SEPTEMBER 1961

Agricultural Engineering

The Journal of the American Society of Agricultural Engineers

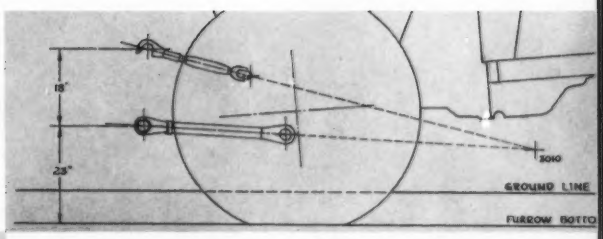
Implement Applications Affect Tractor Design | 478

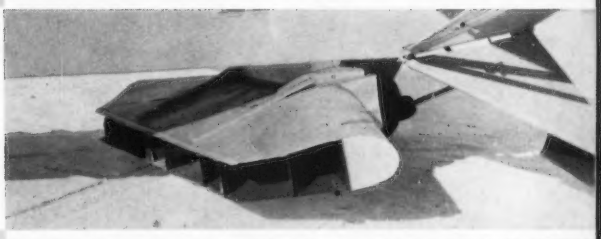
Spreading Dry Materials by Airplane | 484

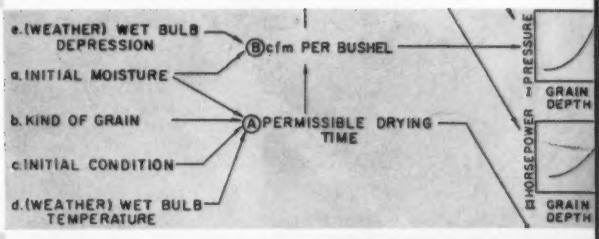
Grain Drying with Supplemental Heat | 488

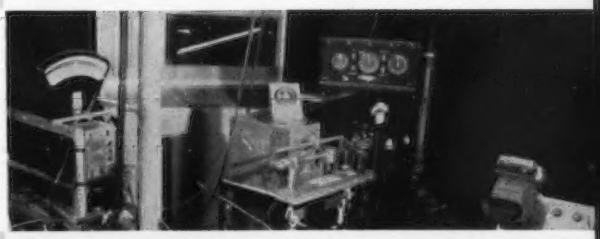
Pulsating Pressures in Engine Induction System | 490

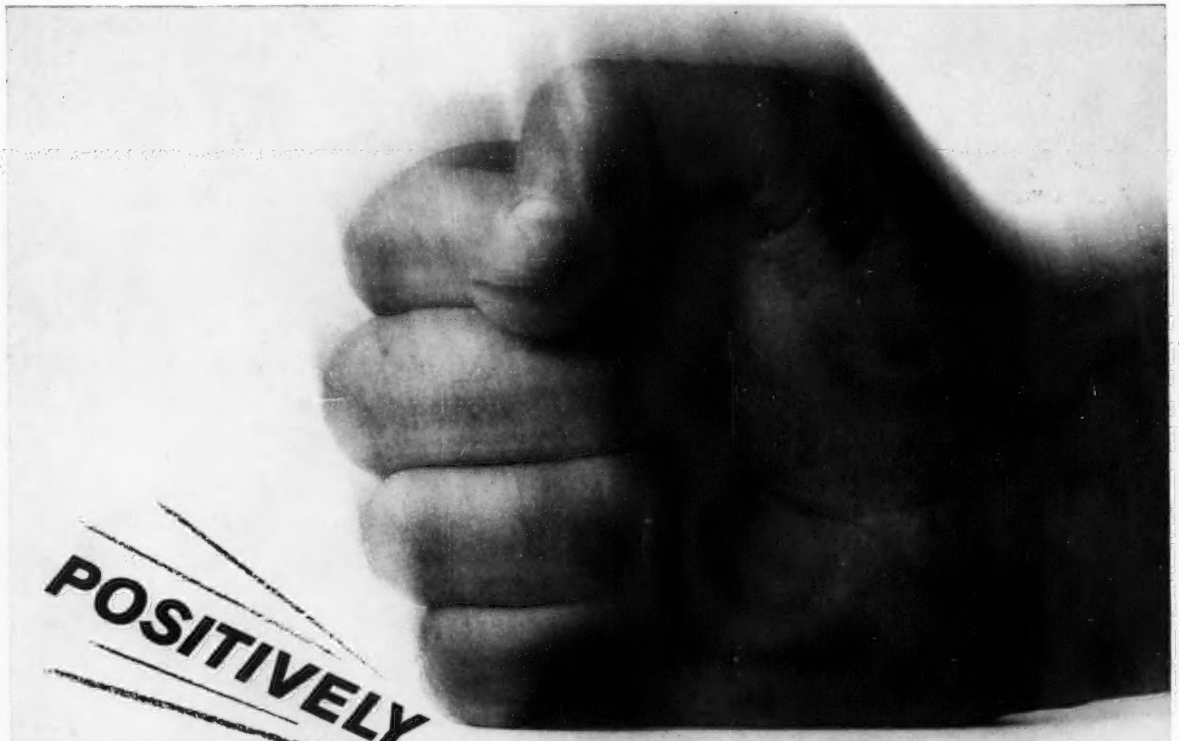
Water Resources in Mediterranean Countries | 494











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You get better, more uniform oil seals as a result of National's 4-part quality program

1. New Seal Design
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In these four separate areas National follows rigid quality control mandates.

Quality Control Managers and teams reporting directly to National's General Manager work with Engineering to establish AQL's—Acceptable Quality Levels—for all new products. They supervise careful inspection of all raw materials in National Seals. They provide production inspection, monitoring performance of Manufacturing and developing new methods of in-process control. And finally, Quality Assurance, which is the periodic, random re-testing of production parts.

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NATIONAL SEAL DIVISION, FEDERAL-MOGUL-BOWER BEARINGS, INC.
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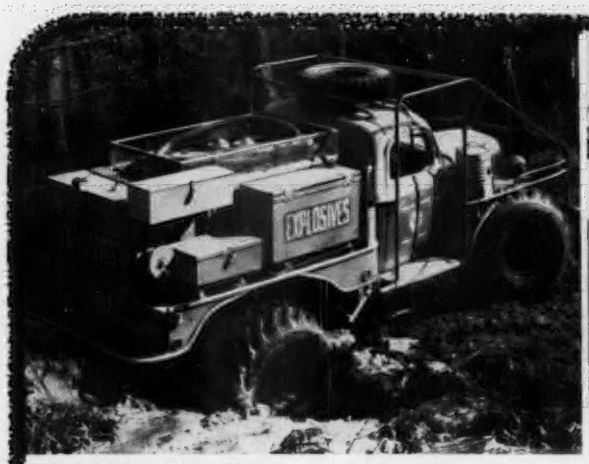
6858

Terra-Tires solved problems on this equipment— How can they help you in your design?



Problem: MOBILITY
Solution: Terra-Tires by Goodyear. Their wide tread, low inflation pressures and high flotation let this truck, owned by Shell Oil Company, easily pull free of a deep bog during an oil exploration.

Problem: FLOTATION
Solution: Terra-Tires by Goodyear. An Indiana company put Terra-Tires on this scraper to prevent delays caused by equipment miring down. Result: Faster peat harvesting at lower cost.

Problem: NON-COMPACTION
Solution: Terra-Tires by Goodyear. A racetrack that's uneven can damage thoroughbreds' legs, so Santa Anita uses tractors with Terra-Tires to condition track after a rain without compacting ground.

Problem: CARGO PROTECTION
Solution: Terra-Tires by Goodyear. Bananas bruise easily, so United Fruit "floats" its fruit from farm to railhead on equipment fitted with Terra-Tires, which also permit all-season hauling.

If you're designing a "go-anywhere" vehicle – or one that must baby its cargo or the ground it goes on—Terra-Tires by Goodyear should be a part of your design. They're available in a wide range of sizes and treads. Let us know what you're driving at—or on—or over, we'll be glad to suggest a design to solve your problem. Write Goodyear, Aviation Products Division, Dept. I-1740, Akron 16, Ohio, or Los Angeles 54, California.

Lots of good things come from

GOODYEAR

Terra-Tire—T.M. The Goodyear Tire & Rubber Company, Akron, Ohio

Agricultural Engineering

Established 1920

CONTENTS • SEPTEMBER 1961 • Vol. 42, No. 9

Report to Readers 470
Partners — Engineers and Industry 477
Frank H. Hamlin
Implement Requirements in Relation to Tractor Design . . 478
W. M. Davis
Spreading Dry Materials by Airplane 484
James E. Henry
Grain Drying with Supplemental Heat 488
W. V. Hukill
Pulsating Pressures in an Internal-Combustion Engine Induction System 490
J. C. McMunn, R. R. Yoerger and J. A. Weber
Water Resource Development in Mediterranean Countries . 494
J. E. Christiansen
Instrument News — Floating Lysimeter 498
W. D. McMillan and H. A. Paul
News Section 501
ASAE Members in the News 502
With the ASAE Sections 506
Events Calendar 506
New Products 508
Check Points — The Technical Coordinator 510
New Books and Films 513
Manufacturers' Literature 514
Personnel Service Bulletin 516
Index to Advertisers 518
Fillers —
Ontario Student Branch Wins Coveted Trophy . . 483
Summary of Research on Individual and Farmstead Water Supplies 493
Aluminum Extrusion Design Awards 497

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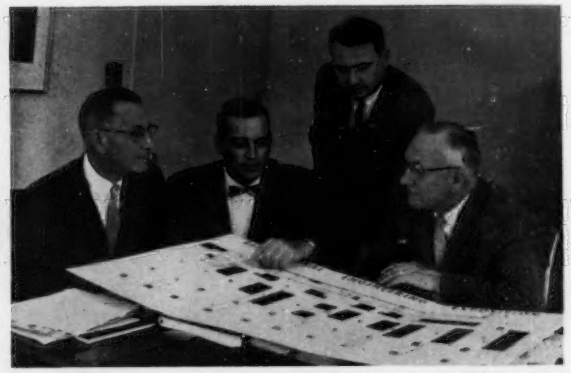
AE Exposition Committee Meets



ASAE Committee on Product Exhibit, Policy and Management met recently to review Agricultural Engineering Exposition progress and to act on any policy matters needing attention. *(Left to right)* J. B. Stere, H. H. Nuernberger (chairman), S. S. DeForest, and N. T. Brenner

CONTINUED progress is reported in the development of the Agricultural Engineering Exposition to be held in conjunction with ASAE Winter Meeting, December 12 to 15 at the Palmer House in Chicago.

An August meeting of the Product Exhibit, Policy and Management Committee was held in Pittsburgh. In attendance were H. H. Nuernberger, development manager, transportation, Aluminum Co. of America (committee chairman); N. T. Brenner, engineer, Gulf Research and Development Co.; S. S. DeForest, industrial representative, Market Development Division, U.S. Steel Corp., and J. B. Stere, product manager, crop drying, New Holland Machine Co.

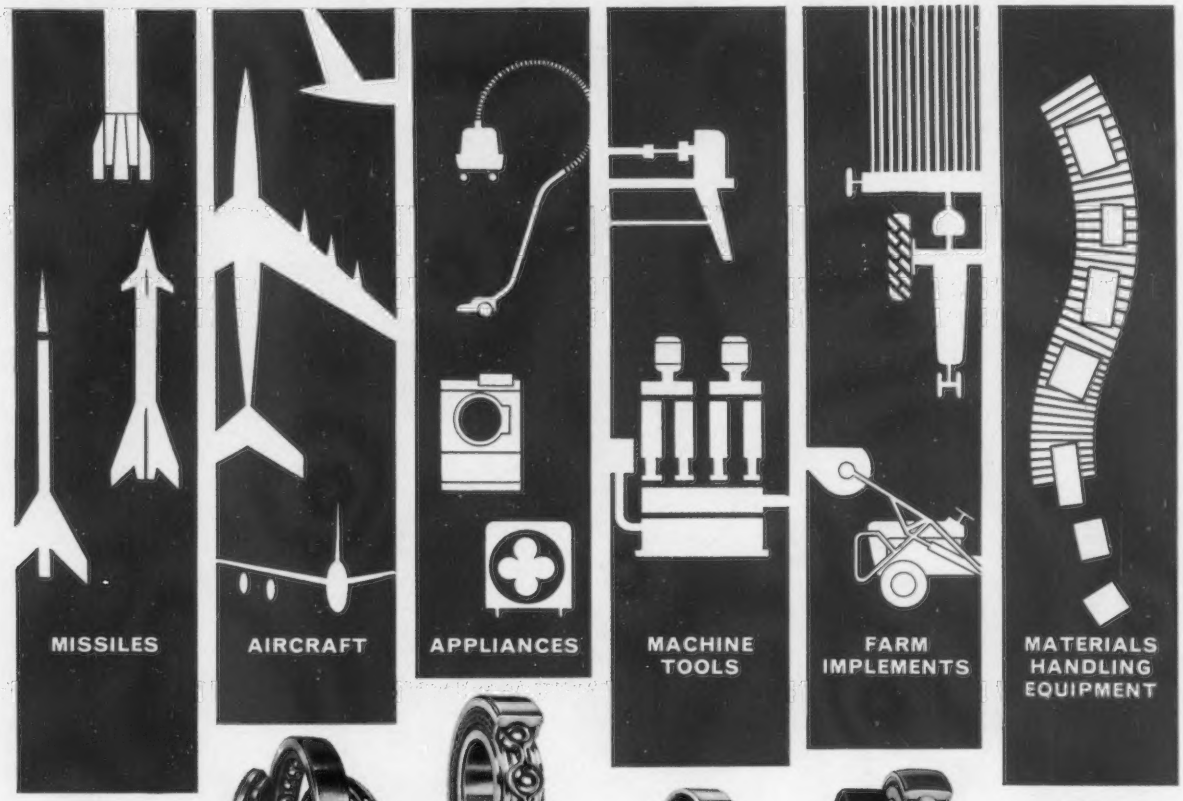
The committee reviewed the progress to date in exhibit space sales and discussed how best to build a high-quality attendance. Since members of ASAE, by virtue of the combined Winter Meeting and Exposition, would form the largest group of visitors to the Exposition, the committee recommended that special efforts should be made to welcome other categories of guests. It discussed the mailing of special invitations to a broad list of executives in industries located within 200 miles of Chicago and endorsed a program of also issuing special invitations to faculty and students of midwest agricultural schools.

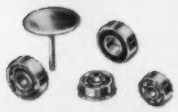
In dealing with policy matters the committee recommended that non-commercial organizations, such as university and college departments and other public service agencies, with projects presented in technical papers at the meeting could be given free exhibit space within the ASAE booth. Exhibits of this type are subject to approval by ASAE and the committee and must have no commercial product promotion implications. It further recommended that any organization with a commercial interest should exhibit its product in paid space. Consideration was also given to the starting time of evening "open house" committee meetings and to the development of an ASAE display.

Of particular interest to the committee members is the variety of products on exhibit in order that the show might have maximum appeal to all in attendance at the ASAE Winter Meeting. With this goal in mind they reported that a special effort is being made to attract exhibitors who manufacture plastics, light metals, forgings, castings, specialty steels, instrumentation, electric motors and controls, and irrigation equipment.

Reservations for exhibit booths may be made by writing to Shea Expositions Corp., One Gateway Center, Pittsburgh 22, Pa.

NEW DEPARTURE PRODUCT INFORMATION





MINIATURE AND INSTRUMENT BALL BEARINGS

Extensive range of ultra-precise ball bearings from ⅛" to 1⅛" O.D. Produced by New Departure to the most exacting requirements found in missile guidance systems and miniature mechanisms of all kinds. Write for catalog—PIB.

AIRCRAFT BEARINGS

Used in today's most advanced engines. Main shaft and accessory drive ball bearings for turbine-driven and reciprocating engines. Designed for ultra-high speeds, heavy loads and high temperature in present and projected air and space vehicles. Write for catalog—ABC.

APPLIANCE AND ELECTRIC MOTOR BEARINGS

A line of quiet-running open, shielded and/or sealed ball bearing types for fractional and integral hp electric motors and machinery of all kinds and makes. Exclusive New Departure integral Sentri-Seals offer Lubricated-For-Life feature. Write for catalog—S.

MACHINE TOOL BEARINGS

A wide range of radial and angular contact ball bearings for spindles and lead screws, made to super-precision tolerances. Also available for gear box and other machine tool applications to precision tolerances. Write for catalog—S.

FARM IMPLEMENT AND EQUIPMENT BEARINGS

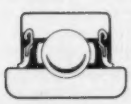
Many types and sizes of integrally sealed bearings, specifically designed to reduce application and relubrication maintenance costs in farm implements and equipment of all kinds. Write for catalog—FIC.

MATERIALS HANDLING, EQUIPMENT BEARINGS

Heavy-duty sealed and Lubricated-For-Life ball bearings for belt and trolley conveyors, lift trucks and other types of materials handling equipment. Write for catalog—CB.

32,000 BALL BEARING TYPES, SIZES AND SPECIFICATIONS

...many available with advanced design integral seals

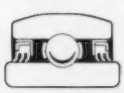


NEW LAND-RIDING SEAL (Crimped)

Efficient single-lip seal protects against moist or dry contaminants. Retains bearing lubricant for life. For farm implement discs, idler pulleys, automotive propeller shafts and rear wheels. Available with metal trash guards.

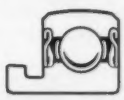
NEW SENTRI-SEAL

N/D's most versatile seal . . . available in most single row, non-loading groove and small double row N/D ball bearings. N/D Sentri-Seals are recommended for general applications where moderate to severe contaminant conditions exist.



NEW TRIPLE-LIP SEAL

Used where moist and dry contaminant conditions are extremely severe. Seal eliminates relubrication maintenance. It's available in N/D square and round bore ball bearings with either spherical or cylindrical O.D.s.



NEW ARMOR-GARD SEAL

Resistant to trash winding and abrasion, Armor-Gard seals are extremely effective under varied field conditions. Here's a highly efficient, low torque, molded synthetic rubber seal which is bonded to and protected by a heavy-duty steel shield.

NEW LAND-RIDING SEAL (Pressed) and SENTRI-SEAL

Exclusive heavy-duty conveyor ball bearing and seal combination. Especially resistant to moist contaminant penetration. Land-Riding Seals (pressed) are also available for many farm implement bearings.

Replacement Ball Bearings Available Through United Motors Service And Its Authorized Bearing Distributors

NEW DEPARTURE

DIVISION OF GENERAL MOTORS CORPORATION, BRISTOL, CONNECTICUT

WAFER FEEDING IS HERE...NOW!

announcing the

"Wafer King"

Lundell

Patents Pending

Why Hay Wafers? — No human hands need handle the hay with Lundell's revolutionary Wafering and Handling System. Wafers can be fed two ways: (1) with push button auger systems, elevators, or tractor loaders, (2) by self-unloader wagons, mixing if desired with grain, silage, concentrates.

The World's First Practical Field Wafering Machine

NOW ROLLING OFF ASSEMBLY LINES for 1961 delivery... the field-proved Lundell "Wafer King."

This lightweight, trail-type machine makes bite-size 1" x 2" or 2" x 2" wafers *right from the windrow.* At a rate up to 6 tons per hour. Early farm tests show storing, palatability, and feeding results beyond all expectations!

Here's Why You Want a Lundell "Wafer King"

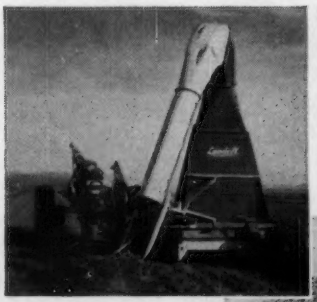
SIMPLE DESIGN — Only three main working parts, (1) Flail Pick-up (2) Rotating Shaft with compression chamber (3) Elevator.

LOW MAINTENANCE — Only nine zerks on entire machine.

OPERATE FROM TRACTOR SEAT—All controls regulated from the tractor seat. Within easy reach of your fingertips are the moisture control, pressure control, wafer density control, hydraulic pick-up control and engine starter switch.

UNIFORM MOISTURE IN WAFERS — No more putting up hay that is too dry. The Lundell Wafers you make at 4:00 p.m. on a normal day will have as much moisture as those you made at 10:00 a.m. You can SEE if the wafers are too dry or too wet. You control the moisture with 8 jets (from 10 gals. an hour to 80 gals.). So, Lundell Wafer is uniform, no stem area, no leaf area. Higher in Vitamin A. With moisture, you can add molasses, urea and Vitamin A preservative.

FIRST MOISTURE CONTROL IN HAYING—"Wafer King" combined with Lundell Chopper and Hay Conditioner Attachment turns the trick. Chopper homogenizes hay for faster drying and uniform finished product. Wafering then starts sooner. "Wafer King" can inject moisture to keep hay from getting too dry.

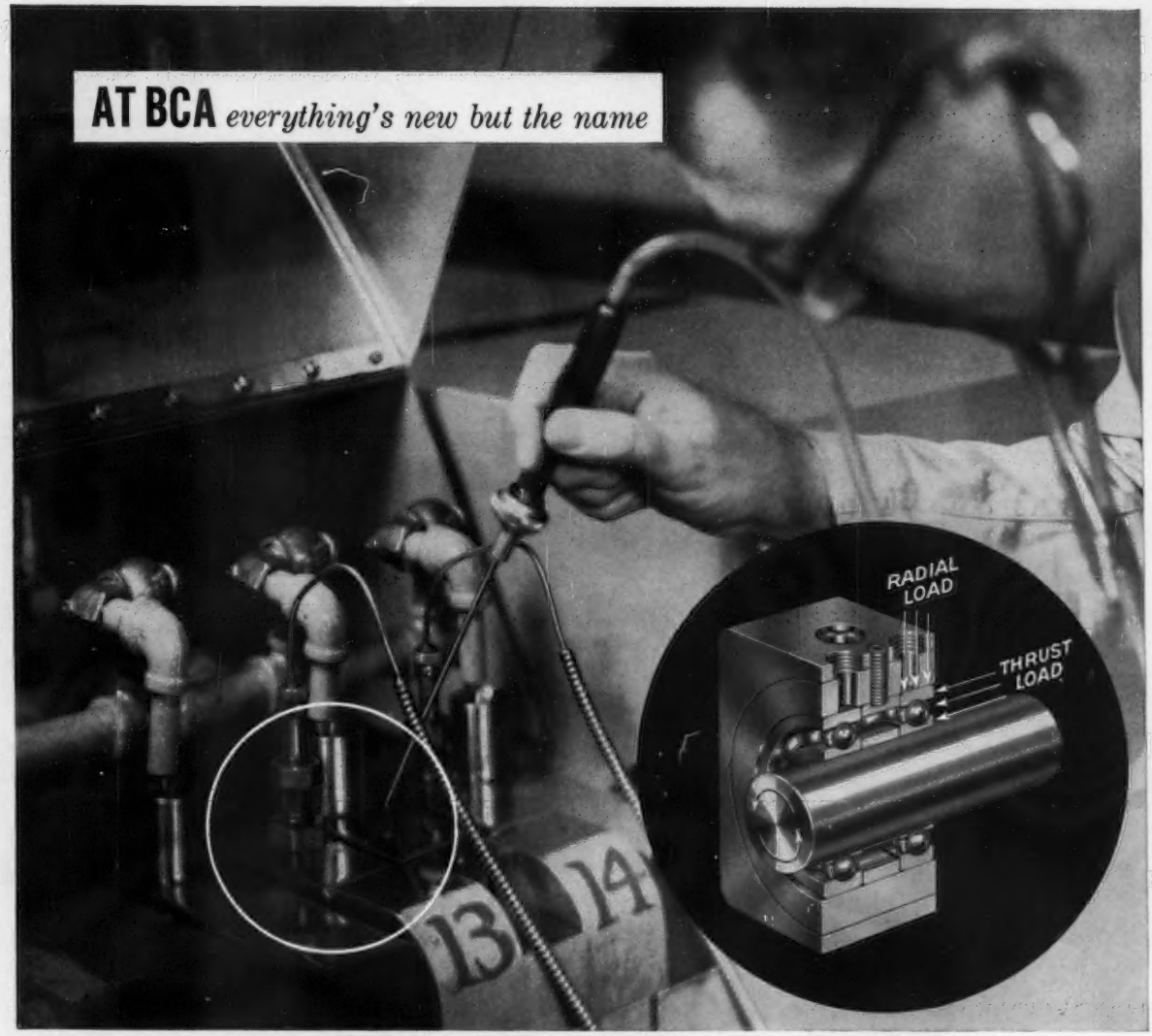


For Superior Wafers—Use Lundell Chopper with Hay Conditioner Attachment. Mow, homogenize, windrow—all in one operation. Gives faster drying, uniform finished product.

Slashes Storage Needs— By one-third to one-half. One ton of Lundell Wafers can be stored in 4' x 4' x 5' area. No danger of fire either. Shown is how one Lundell owner stores wafers.

See the "Wafer King" at our factory. Write for name of nearest Lundell Dealer who will make all arrangements for you.

LUNDELL MANUFACTURING CO., INC., Dept. AE-9, Cherokee, Iowa



BALL BEARING "HEARTBEATS"

checked with unique new fatigue tester

With a stethoscope checking the "heartbeats," this unique fatigue tester is putting BCA ball bearings through a battery of exaggerated, but controlled, speed and load tests.

The fatigue testing machines are part of a group of testing devices that provide essential data for BCA's research program. Hydraulically testing BCA bearings at a variety of rotational speeds and under many combinations of radial and thrust loads, each machine checks to see that BCA ball bearings are maintaining the highest fatigue life standards . . . evaluates the fatigue characteristics of new ball bearing materials and new processing methods . . . helps select ball bearing lubricants to provide the longest possible fatigue life.

These machines and BCA's other unusual testing devices are designed and built to help us develop the highest quality ball bearings available. By simulating actual operating conditions, BCA ball bearings can be tested to *exceed* customer specifications.

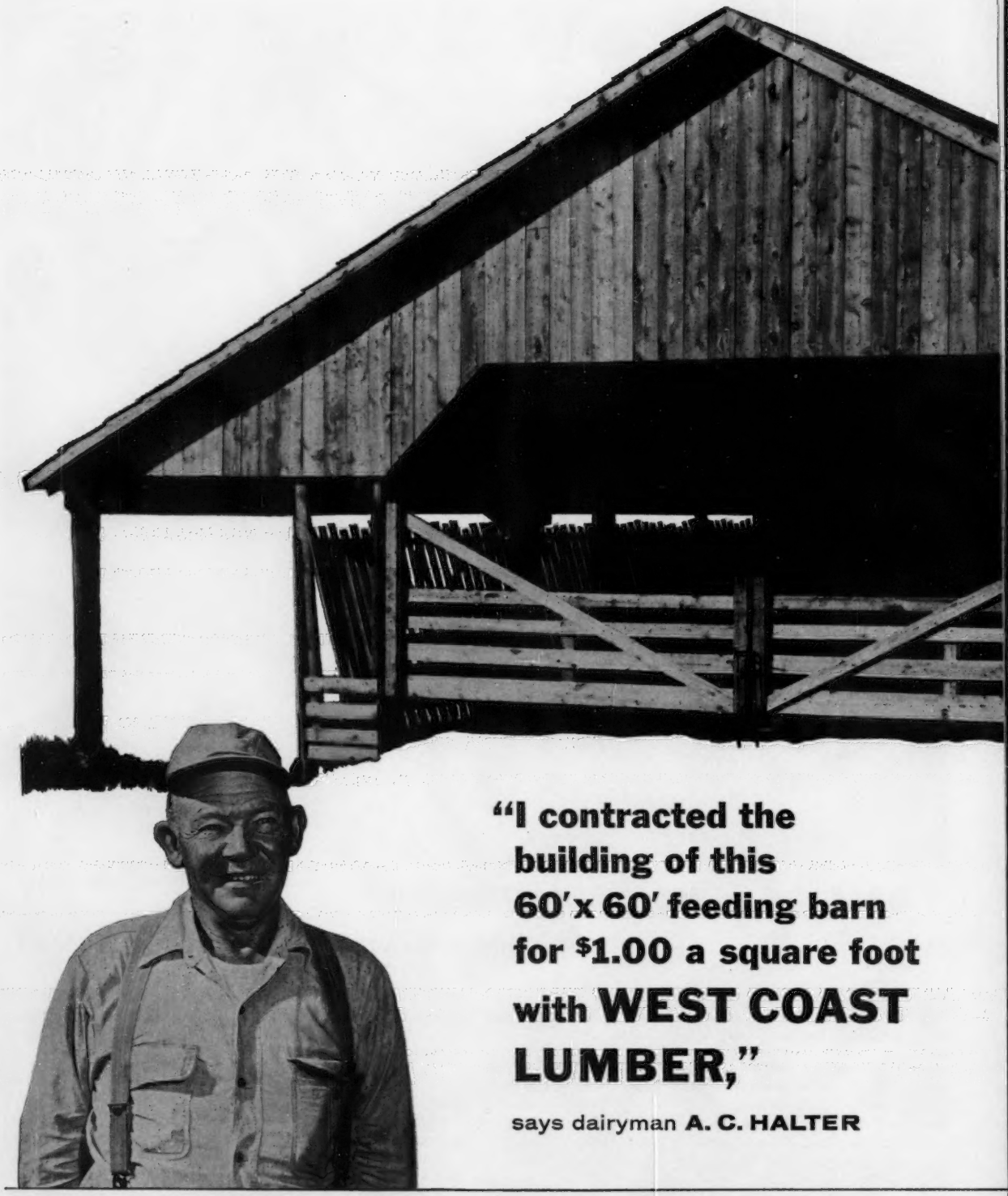
BCA ball bearings are standard equipment throughout industry—for both original and replacement applications. BCA's complete line of ball bearing types and sizes . . . design, engineering and manufacturing skill . . . plus research and testing facilities, are some of the reasons that automotive, machine tool, earth moving, agricultural equipment manufacturers specify BCA. We'd like to serve you—with high-performance bearings or technical assistance. Contact Bearings Company of America, Division of Federal-Mogul-Bower Bearings, Inc., Lancaster, Pa.

BCA

BEARINGS COMPANY OF AMERICA

ball bearings

DIVISION OF FEDERAL-MOGUL-BOWER BEARINGS, INC.



"I contracted the building of this 60′ x 60′ feeding barn for $1.00 a square foot with WEST COAST LUMBER,"

says dairyman **A. C. HALTER**

WEST COAST LUMBER

WEST COAST DOUGLAS FIR • WEST COAST HEMLOCK
WESTERN RED CEDAR • SITKA SPRUCE • WHITE FIR

"I got the most for my money by using WEST COAST LUMBER in building my new pole type feeding barn. All of my farm buildings are built with lumber and have proved the best dollar for dollar investment," Halter points out.

This 60′ x 60′ feeding barn has a 30′ x 60′ storage for 5,000 bales of hay and has two 15′ x 60′ covered feeding racks for 75 head. The poles are spaced 15′ on centers to permit cleaning the feeding area with a tractor.

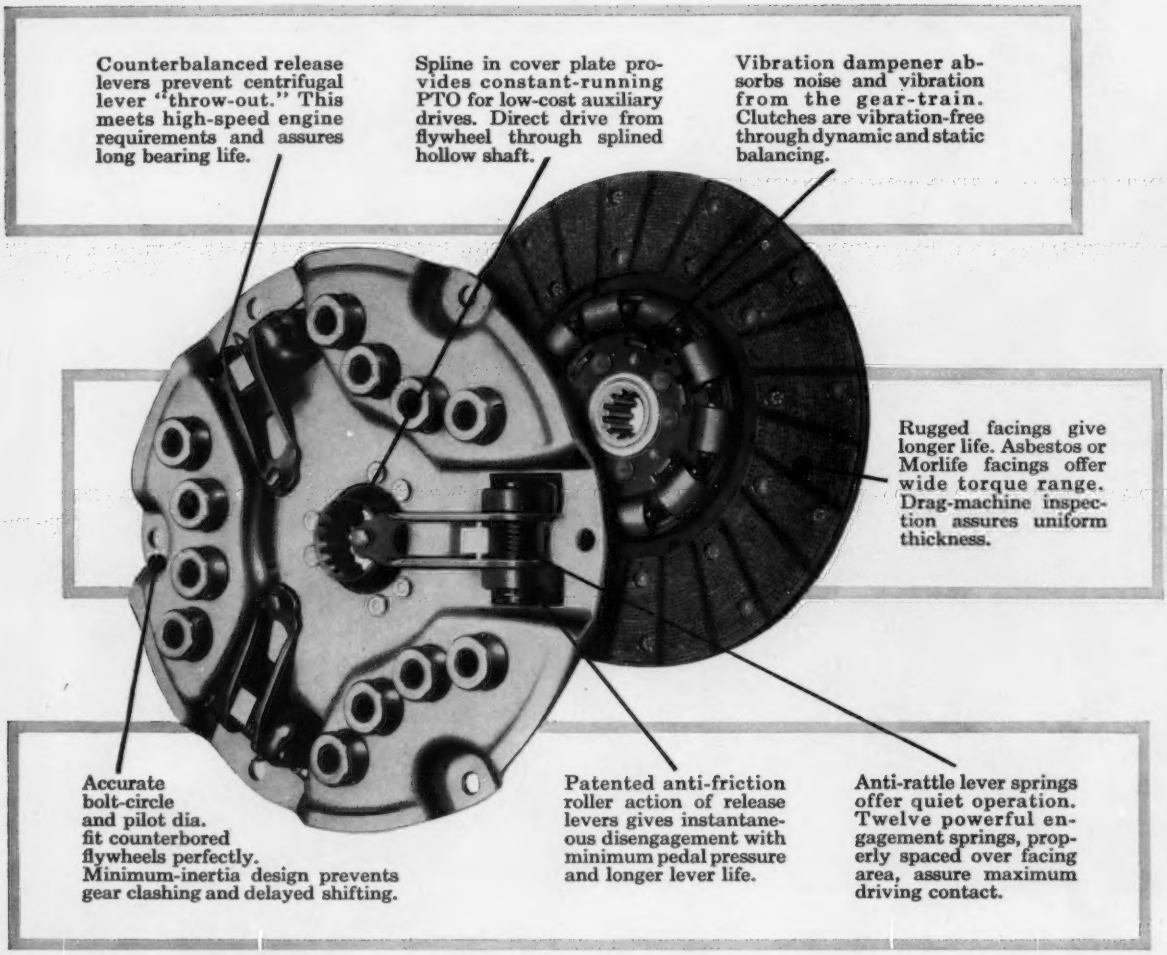
Plans for the feeding barn resulted in the taking of features from other barn plans and adapting to dairyman Halter's specific needs – easily accomplished with West Coast Lumber.

Dairyman Halter describes his new feeding barn as "simple construction." The truss rafters are 2″ x 6″ nail laminated with 8″ x 16″ West Coast Douglas Fir timbers used for beams placed on top of the poles. Western Red Cedar 1″ x 6″ boards were used for nailing strips to fasten cedar shake roof in place. Siding is 1″ x 12″ cedar. Feeding racks have been built with 2″ x 4″ West Coast Douglas Fir.

Here is another example of West Coast Lumber adapting to meet a Farm Building requirement – economically. Consult with your local retail lumber dealer about using West Coast Lumber to meet specific farm building needs.

WEST COAST LUMBERMEN'S ASSOCIATION

1410 S. W. Morrison Street • Portland 5, Oregon


Counterbalanced release levers prevent centrifugal lever "throw-out." This meets high-speed engine requirements and assures long bearing life.
Spline in cover plate provides constant-running PTO for low-cost auxiliary drives. Direct drive from flywheel through splined hollow shaft.
Vibration dampener absorbs noise and vibration from the gear-train. Clutches are vibration-free through dynamic and static balancing.
Rugged facings give longer life. Asbestos or Morlife facings offer wide torque range. Drag-machine inspection assures uniform thickness.
Accurate bolt-circle and pilot dia. fit counterbored flywheels perfectly. Minimum-inertia design prevents gear clashing and delayed shifting.
Patented anti-friction roller action of release levers gives instantaneous disengagement with minimum pedal pressure and longer lever life.
Anti-rattle lever springs offer quiet operation. Twelve powerful engagement springs, properly spaced over facing area, assure maximum driving contact.

NEW Dual-Drive FA Clutches meet your high-speed engine needs

The new Rockford FA Spring-Loaded Clutches are specially designed for your high-speed engines. Counterbalanced release levers permit high-speed operation without increasing pressure required to release. High-strength, low-inertia design gives high-speed drives without gear clashing or delayed shifting. Patented anti-friction roller action of release levers allow instantaneous disengagement with lower pedal pressure and longer lever life. FA dual-drive clutches provide a built-in live power take-off. This low-cost auxiliary drive runs constantly from flywheel through splined hollow shaft. Through a choice of springs and facings, FA Clutches are available in a wide range of torque capacities. Write today for complete information.

International Harvester 660 Tractor equipped with Rockford FA Spring-Loaded Clutch.

ROCKFORD CLUTCH
1201 WINDSOR ROAD, ROCKFORD, ILLINOIS
Export Sales Borg-Warner International • 36 So. Wabash, Chicago, Ill.

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John Deere Loaders and Spreaders speed manure handling for your customers, speed sales for you.

Rated "Tops" with farmers everywhere . . .

John Deere **Manure-Handling Equipment**

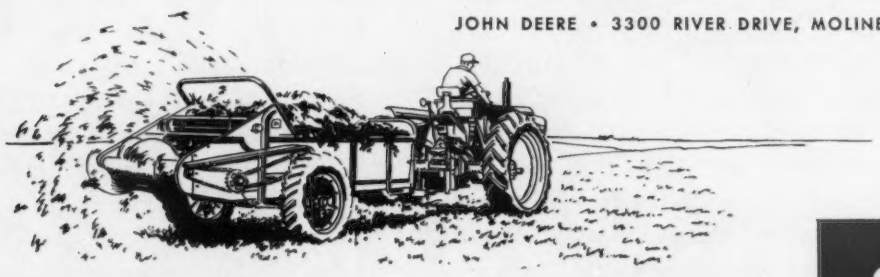
5 HIGH-SPEED SPREADERS

There's a John Deere Spreader tailored to fit your customers' needs, no matter what size their dairying or livestock-feeding operations. In ground-driven spreaders, the 76-bushel "L" and the 95-bushel "R" fill the bill. With PTO drive, there's no topping the 95-bushel "W" the 118-bushel "33," and the 134-bushel "N" for fast, all-weather work. John Deere Spreaders are built from hitch to widespread to give extra years of trouble-free service.

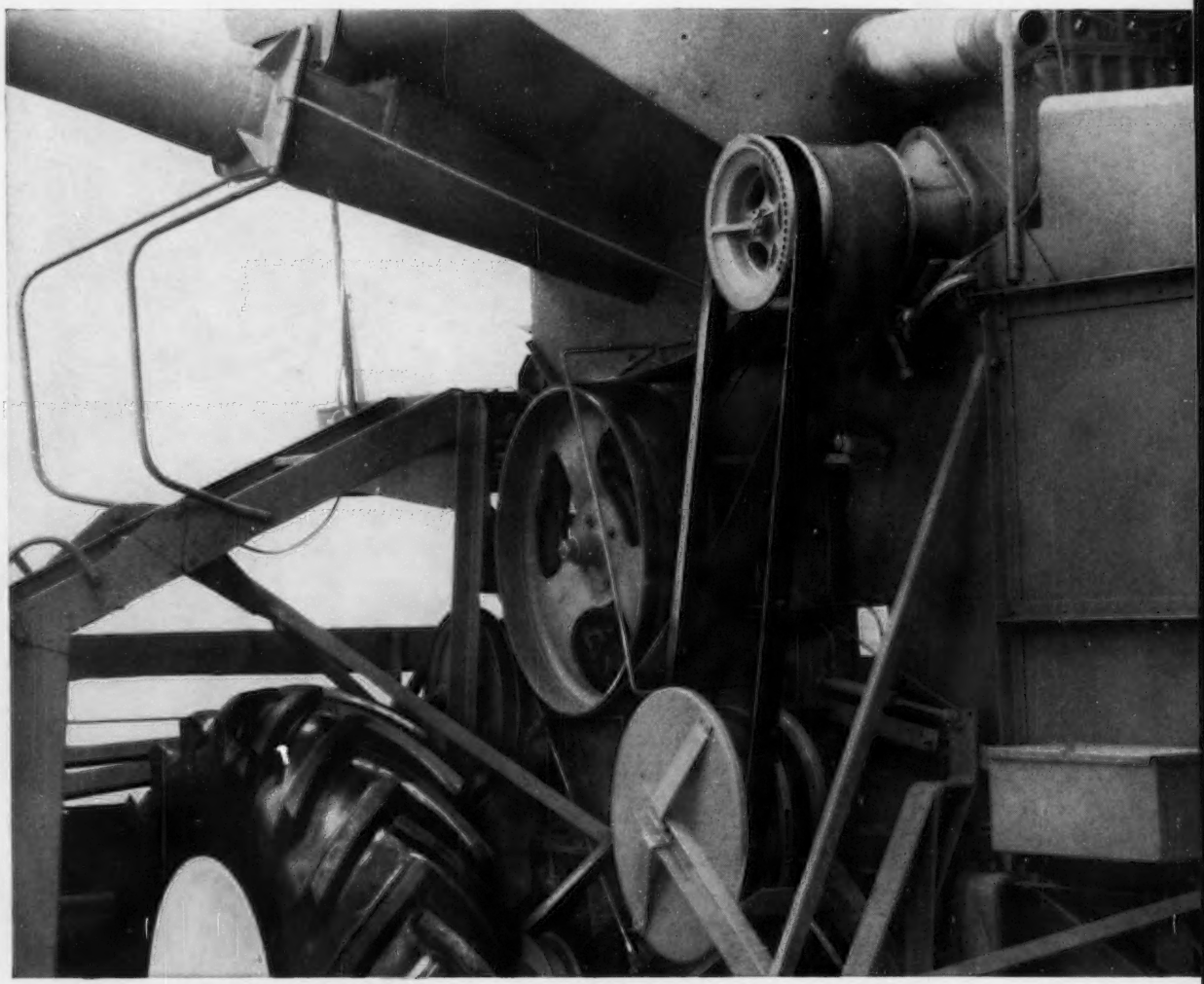
3 POWERFUL LOADERS

Rounding out John Deere's manure-handling team are three smooth-working loaders with time-saving features galore. The 35, 45, and 45-W are loaders that your customers can put on, or take off, in 10 minutes or less with no heavy lifting. These loaders utilize a tractor's "live" hydraulic system—completely eliminate clutching and shifting in raising and lowering. They have built-in strength throughout to give dependable, low-cost service.

JOHN DEERE • 3300 RIVER DRIVE, MOLINE, ILLINOIS



JOHN DEERE design, dependability, and dealers **MAKE THE DIFFERENCE**



Power for "World's Largest Combine" transmitted by Dayton V-Belts

John Deere's new self-propelled Model 105 . . . 22-foot cut, 50-inch cylinder, 6930 square inches of separating area. A giant machine . . . with unmatched capacity, power, output! And *approved for Dayton are V-Belt Drives* for augers, elevators, screens, attachments, straw walkers, straw spreaders, blowers . . . *plus the all-important propulsion drive!* Shown above, this Dayton Variable-Speed V-Belt Drive links engine and four-gear transmission . . . provides an infinite variety of ground speeds, 0.60 mph to 12.56 mph. Its main advantages: dependability plus protection against shock loads.

Approval of Dayton V-Belts for this huge combine stands as a tribute to the cooperative efforts of John Deere and Dayton engineers. Working together, they developed and adapted this dependable and economical source of power transmission. Dayton V-Belts passed—and continued to pass—all the rigorous laboratory and field tests given them by John Deere. And on-the-job performance has continued to be very good!

Heart of the 105's Selective Ground-Speed Control. Upper sheave is attached to end of engine crankshaft. Double sheave on swing frame varies speed and transmits power to lower sheave and transmission. Dayton V-Belt Drive thus permits combining at a wide range of ground speeds . . . also protects the "World's Largest Combine" against shock loads.

Dayton furnishes John Deere many different types of V-Belts. Besides level-land combines—both self-propelled and drawn—they transmit power for Deere hillside combines, mowers, windrowers, forage harvesters, field choppers, crop dryers, corn and cotton pickers, beet harvesters, and stone pickers. Dayton *automotive* belts and hose are also used in John Deere farm and industrial tractors.

From tough cover to prestressed cords, Dayton's variable-speed arch-type V-Belt is designed for high traction, low slippage and long life. Preformed arch eliminates squashing and dishing, helps take up load shocks. High-modulus cords assure low stretch properties; laminated compressed fabric assures high crosswise rigidity.

Dayton field and laboratory assistance is available to help solve your *V-Belt power transmission problems, too, and to guarantee dependable, low-cost operation for your every equipment need. For details, write:*

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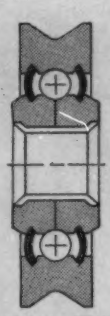
Dayco CORPORATION

Dayton Industrial Products Co. Div. Melrose Park, Illinois

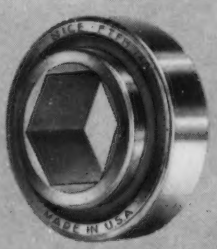


No. 6750-3
WIRE GUIDE
ROLLER FOR
HAY BALER
Approx. 1½ Size

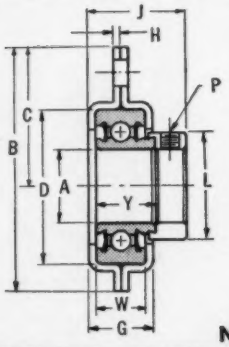
NICE *Bearings for Farm Machinery*

FLANGE MOUNTED BEARINGS are widely used by Agricultural Engineers because of their mounting simplicity and cost saving possibilities. NICE FTF flange mounted bearings offer the ultimate in mounting simplicity, cost saving *and* performance, by combining the advantages of the revolutionary new UNIBAL construction with use of a unique new seal especially developed for farm machinery service.

UNIBAL construction and patented manufacturing methods produce bearings with exceptional durability and strength and the new seal effectively retains lubricant and excludes dust, dirt and moisture, even under the most adverse conditions of operation.

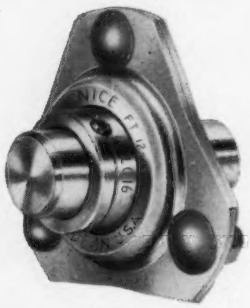


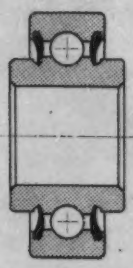
Type FTFH MULTI-PURPOSE HEX BORE RADIAL BEARING, designed for use with or without FTF flanges. Approx. Half Size



In addition, NICE produces many other standard and special farm machinery bearings such as wire guide bearings, cam followers, power take-off bearings, idlers, disc and wheel bearings, some of which are illustrated.

Write for Catalog FM100



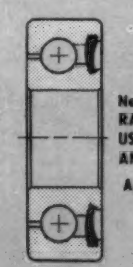


No. 7366H
MULTI-PURPOSE
RADIAL BEARING
WITH EXTENDED
INNER RACE
Approx. Full Size

NICE FTF Flange Mounted Bearings

BEARING NO. (complete)	A +.005 −.000	B max.	C max.	D +.000 −.001	Dia. Bolt Circle	Square Bolt Hole	G	H	J	L	P	Y	W
FTF12	¾												
FTF14	⅞	3.328	1.921	2.0472	3.	11/32	.791	.083	1.290	1 1/16	¼ 28 thr.	.765	.625
FTF16	1.												
FTF17	1 1/16	3.968	2.218	2.3125	3 5/16	13/32	.843	.109	1.316	1¼	¼ 28thr.	.765	.625
FTF18	1⅛												
FTF20	1¼												

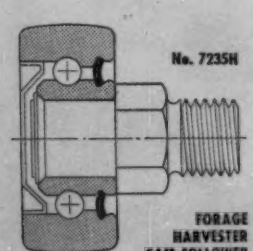
Note: All FTF flange bearings can accommodate up to plus or minus ½ degree misalignment



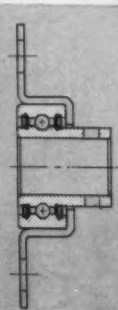
No. 7374-2
RADIAL BEARING
USED IN FERTILIZER
AND SEED OPENERS
Approx. Full Size

NICE®

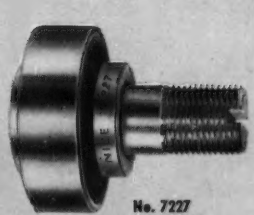
NICE BALL BEARING CO.
NICETOWN • PHILADELPHIA • PENNSYLVANIA



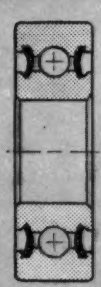
No. 7235H
FORAGE
HARVESTER
CAM FOLLOWER
Approx. Full Size



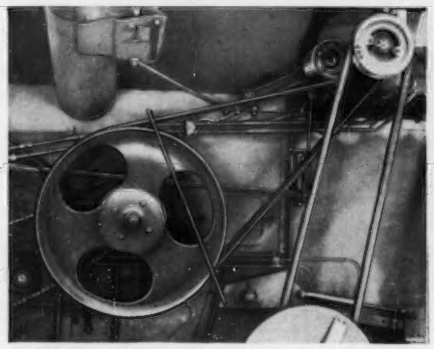
No. 7289-1
FLANGE MOUNTED
RADIAL BEARING
ASSEMBLY FOR USE
IN PLANTER
PRESS WHEEL
Approx. Half Size



No. 7227
HAY RAKE
TINE BAR
BEARING AND BOLT
Approx. Half Size



No. 7231-2H
MULTI-PURPOSE
RADIAL BEARING
Approx. Full Size



Close-up of Deere unit shows Condor Flat Whipcord Belt on a separator drive and two Manhattan Agricultural Traction Drive V-Belts transmitting power from engine to wheels through a variable speed sheave.

MANHATTAN AGRICULTURAL BELTS

Meet Modern Equipment Design Requirements

On job-proven farm equipment like the John Deere 95 Combine pictured above, Manhattan Agricultural Belts assure positive power delivery and long service life where it counts the most—in field operation.

Manhattan belting engineers draw on more than 60 years of rubber technology and experience to produce the most reliable and economical belts available today. The exclusive Extensible-Tip Splice on Condor Whipcord Belts, for example, is a feature found in no other endless farm belt. Other engineered features of strength, flexibility and long service life built into Condor Whipcord Belts and Manhattan Agricultural V-Belts contribute to the success of farm equipment by making power drives as trouble-free as possible.

Let R/M show you why Manhattan Agricultural Belts have won the confidence of leading farm machine manufacturers . . . how they can add "More Use per Dollar" to the equipment you design or produce.

ENGINEERED FOR FARM EQUIPMENT DRIVES

• MANHATTAN AGRICULTURAL V-BELTS • CONDOR WHIPCORD ENDLESS BELTS

• R/M POLY-V® DRIVES

RM1000R

RAYBESTOS-MANHATTAN, INC.

MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY

RM

ENGINEERED RUBBER PRODUCTS . . . "MORE USE PER DOLLAR"

Report to Readers . . .

A STAINLESS STEEL-PLASTIC TECHNIQUE FOILS CORROSION — A new technique that appears to have promising application in manufacturing provides for encasing some or all of an iron or steel machine part, exposed to corrosion, in a twin-layered jacket consisting of stainless steel and epoxy resin. . . . . The encasing process is simple. Stainless steel foil 0.002 inch thick is shaped within a mold to fit over the product to be protected. This stainless shell is then fitted into place, leaving a small space on all sides between foil and product. (The stainless steel foil is tough so that tearing is not a problem.) An epoxy resin is next poured between the stainless shell and the product. (A temporary mold prevents rupture of the foil due to weight of the resin as it is poured.) Hardening of the resin not only completes the process of encasing the product with stainless steel to provide the desired corrosion resistance, but it also provides the necessary mechanical support. . . . . Cost of the process is said to be low, and the service life of a product thus protected is much increased due to lack of corrosion.

ARTIFICIAL GRAIN DRYING – BOON TO GROWERS, CAN TROUBLE BAKERS — The report of a USDA-Kansas AES research study of artificial grain drying states that, while the practice is a boon to wheat growers when the weather during harvest is too wet, it sometimes creates trouble for bread bakers. While reducing the moisture in the wheat for safe storage, artificial drying may damage the milling and baking qualities of the grain. . . . . The scientists say the high temperatures cause the endosperm of the wheat kernel to swell and shatter, though the seedcoat does not rupture – the same action that causes popcorn to pop. They report also that it takes less heat to damage high-moisture wheat. Wheat of lower initial moisture content will tolerate a higher temperature without harm.

FOOD ENGINEERING – A NEW ERA OF COOPERATIVE SCIENTIFIC RESEARCH — That food engineering research offers a challenging field for young scientists – agricultural engineers and food scientists in particular – is what a Michigan SU agricultural engineer told an ASAE meeting recently. Food engineering is a rapidly developing new field of cooperative scientific research, for which agricultural engineers are especially well suited by background, education and interest. Such research can best be carried on cooperatively between these engineers and food scientists. Discovery of new ways of processing foods, resulting from application of engineering principles and techniques to food industry needs, is responsible for many of today's better food products.

PREDICTS MINIMUM TILLAGE MAY REVOLUTIONIZE FIELD PRACTICE — A Nebraska U agricultural engineer predicted at an ASAE meeting that the so-called "minimum tillage" system of land management may revolutionize current field practice in corn and sorghum production. The Nebraska engineers have developed a till-plant machine for planting in cornstalk residue without prior tillage. Resulting crop yields have been as high as those produced under the best conventional tillage systems. . . . . In the 1960 trials at 16 different locations in the state, yields varied from 53 to 151 bushels per acre, with till-plant plots averaging 119 bushels per acre and conventional tillage plots 117 bushels. It was further observed that, on the average, till-plant plots could be harvested one week earlier, for the reason that moisture content of the grain was lower than that from conventional-tillage plots. . . . . The Nebraska engineers also say an annual saving of $7.50 per acre in field operating costs is possible with the till-plant system. *(Continued on page 472)*

75-MILLIONTHS OF AN INCH BARRIER HALTS METAL MIGRATION

JUST BENEATH THE FRESH OVERPLATE OF THESE F-M ENGINE BEARINGS (LEFT) LIES A TENUOUS DIFFUSION BARRIER. Though this film of metal is only 75-millionths of an inch thin, it stops tin in the overplate from migrating into the lining metal beneath. Its presence is important to bearing overplate performance, particularly during the critical period of engine break-in. Maintaining uniform thinness as well as uniform composition of the plated barrier is most important . . . and most difficult to achieve on a production scale. Federal-Mogul research has developed a unique, extraordinarily precise method for controlling both the thinness and the metallic composition of this barrier, within narrow limits. And the performance of F-M engine sleeve bearings attests to the success of the method!

RESEARCH INTO ELECTROPLATING problems is a continuing project in the F-M laboratories. Unusual precision equipment and facilities are employed, many of which have been specially designed and engineered by F-M to solve problems of sliding-bearing application. As a result, Federal-Mogul engineered sleeve bearings, precision thrust washers, formed bushings, and low-cost spacers provide the finest possible performance characteristics for any application.

Have you a problem with bearings, bushings or washers? Are you considering the development or redesign of an item of the type shown above? We'll be glad to show you how the job can be done most effectively and economically. For information, write Federal-Mogul Division, Federal-Mogul-Bower Bearings, Inc., 11081 Shoemaker, Detroit 13, Michigan.

FEDERAL-MOGUL

sleeve bearings
bushings-spacers
thrust washers

DIVISION OF
FEDERAL-MOGUL-BOWER
BEARINGS, INC.

. . . Report to Readers (Continued from page 470)

EXPANDING HORIZON FOR TRAINING ENGINEERS TO SERVE AGRICULTURE

The first graduates with professional degrees in agricultural engineering, to come from the land-grant colleges early in this century, were trained for dealing mainly with on-the-farm production problems. Today's training is far different. As was recently stated by a college agricultural engineering department head, present-day agriculture finds its best interest lies in concerning itself not alone with problems of production, but also of transportation, processing and marketing. Accordingly, if agricultural engineers are to fulfill their function of serving agriculture, both directly and indirectly, it is essential that they be prepared to fill positions in manufacturing, processing and other industries where their particular qualifications may be needed. . . . . Increasingly college curriculums in agricultural engineering are now making such preparation possible. Students are receiving training in sanitation, bacteriology, and in the appreciation of biological factors of food and fiber which makes graduates particularly adapted to dealing with problems in food and fiber engineering.

NEW IDEA IN STORING HIGH-MOISTURE CORN

Illinois AES agricultural engineers are investigating the use of ear-corn cribs and shelled-corn bins for storing high-moisture corn, in cooperation with a manufacturer of packaging materials. A moisture-proof material made of paper coated with a layer of polyethylene film and aluminum is used to line cribs or bins. Though only about 1/10 inch thick, the material is as rigid as heavy cardboard and is easily applied to the inside of a bin or crib. It is held in place with nails, screws, or bolts, and it can be cut, creased, or bent into almost any shape. One of its main advantages is that it remains in place following removal of the grain.

NEW MACHINE HARVESTS CASTOR BEANS ON EXPERIMENTAL PLOTS

A USDA agricultural engineer and Oklahoma AES researchers have developed a special device for harvesting castor beans grown on experimental plots. It is designed for mounting on the rear of a small tractor. . . . . The tractor is reversed to drive backwards, and the driver's seat and tractor controls are also reversed. This permits the operator to look directly down upon the header which removes the beans from the plants. The beans are then conveyed by augers to sacking attachments, where a worker sacks the beans, labels the bags and stacks them on a platform trailer. . . . . This two-row device permits much faster harvesting than by hand (the usual practice) which results in less loss of beans from shattering. The machine harvests a plot two rows wide and 20 feet long in approximately 1½ minutes. About ¾ man-hour per plot is required for harvest-by-hand, plus additional supervisory help. . . . . In addition to saving labor, this harvester gives researchers a good indication of whether new varieties being developed will be suitable for machine harvesting on a commercial basis.

RESEARCHERS TRY RAISING SWINE ON SLATTED FLOORS

Illinois AES agricultural engineers are studying the use of slatted floors for growing and finishing hogs. Test floors using three different materials – concrete slats, wood slats and quarry screen – were selected. The main purpose of the experiment is to observe the pigs during finishing and to determine the relative merits of the three materials. . . . . Movement of the animals works the droppings through the slats in the floor, thereby keeping themselves clean. The manure can then be removed from underneath free of interference from animals and equipment. . . . . The pens are about 6 by 12 feet, and there are 10 pigs to each pen. The area of the pens was not changed during the growing cycle. . . . . While the quarry screen proved superior in self-cleaning action, the hoofs of pigs raised on it showed some wear. Pigs raised on concrete and wood slats showed no visible ill effects. On the basis of all factors involved, concrete would seem the best all-around choice.

How to get new attachment ideas "off the shelf"

You literally pick new chain attachment ideas right off the shelf when you call in your Rex Agricultural Chain Engineer. He brings to your development program the industry's most complete line of attachments. Here you'll quickly find the exact type you need to solve the toughest implement problem. Or you'll find a type that sparks the idea for just the special attachment you need.

A prototype is in your hands quickly because CHAIN Belt's engineering and production facilities are geared for special service. Many of today's popular standard attachments were developed as Rex "overnight" specials—products of CHAIN Belt's ability to move quickly and surely in designing and producing the right answers to your implement design problems.

Invite your Rex Agricultural Chain Engineer in when he can be most helpful—at the planning stages. He's equally at home in the field and beside the drawing board.

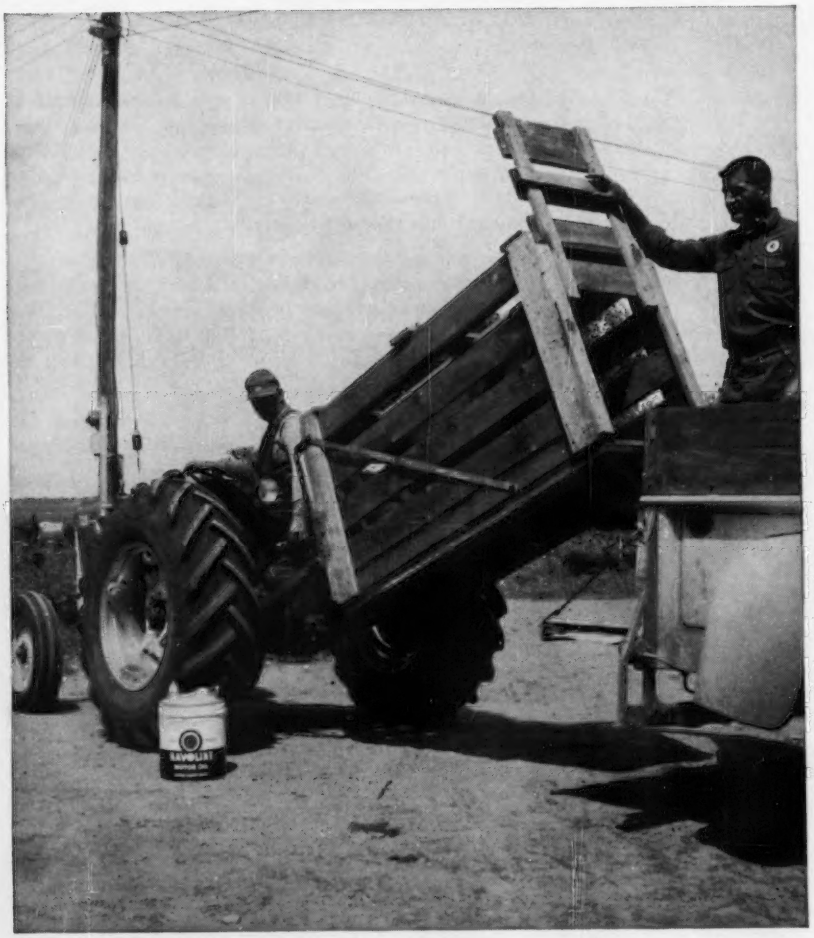
FREE AGRICULTURAL CHAIN CATALOG No. 61170 shows you the complete line of Rex Agricultural Implement Chains and attachments.

Contact your local CHAIN Belt district office. Or, write CHAIN Belt Company, 4681 W. Greenfield Ave., Milwaukee 1, Wis. In Canada: CHAIN Belt (Canada) Ltd., Toronto and Montreal.

REX®

AGRICULTURAL IMPLEMENT CHAINS AND ATTACHMENTS

HIS PORTABLE HOG CRATE MAKES PICK-UPS EASY!



This one-man portable hog crate "invention" saves time and labor for Mr. George Hill, who farms 180 acres near Manly, Iowa. It enables him to round up and cage stray hogs, including litters, in the field. They are then hauled quickly to the road, where the tractor's hydraulic control easily lifts the crate to a waiting truck.

After five years of using Texaco Products to lubricate and fuel his tractors and other farm equipment, Mr. Hill is convinced they are best for economical operation and longer machinery life. He prefers Advanced Custom-Made Havoline Motor Oil, for example, because it wear-proofs engines and cleans as it lubricates. He also uses Texaco Marfak lubricant, because it sticks to open bearings better. Like farmers all over the country, this progressive farmer has found that it pays to farm with Texaco Products.

SHOWN IN PHOTO *(left to right) are Mr. Hill and Texaco Consignee M. L. "John" Benn, of Mason City, Iowa, who provides neighborly, on-time deliveries to his customers.*

IT'S TEXACO FOR HIM!

Mr. Bruce O. Nicholes, who grows 150 carloads of potatoes annually on his 500-acre farm near Madras, Oregon, likes the lively power of Fire Chief gasoline for his 5 tractors. Fire Chief is Climate-Controlled, specially blended to match year-'round temperature changes. As a result, engines run more efficiently with this great gasoline, saving farmers money on fuel. Photo shows Mr. Nicholes (with dog) passing the time of day with Texaco Consignee J. Newell Dana, of Madras, Oregon.

BUYTHE BEST..BUY TEXACO

TUNE IN TO THE HUNTLEY-BRINKLEY REPORT, MONDAY THROUGH FRIDAY, NBC-TV

New steels are born at Armco

ARMCO PRODUCTS EASE FARM ROAD PLANNING

Planned farm roads are an important factor in total farm economy. Farm road drainage is equally important.

Proper farm road planning expedites traffic to and from fields and opens tillable areas to full use. Proper farm road drainage cuts surface maintenance, reduces equipment wear and helps protect crops in adjacent fields from destruction by flooding.

Armco offers a complete line of efficient, durable, cost-saving road drainage structures. They range in diameters from six inches up. They're available in almost any length, and can be coated to assure long service life under corrosive conditions. They won't crack, break or disjoint. And they'll hold up under the weight of heavy farm equipment.

Armco Corrugated Metal Drainage Structures are distributed through a wide network of dealers across the country. To get the names of dealers in your area, write Armco Drainage & Metal Products, Inc., 6331 Curtis Street, Middletown, Ohio.

Steel — For durable drainage structures

ARMCO Drainage & Metal Products

THE '61 FORD

beautifully built to be more service-free...inside and out!

■ **Bold, imaginative engineering produces many new minimum-service features for the Ford Fine Car Family.**

Inside and out, the Ford Family of Fine Cars is designed to require less servicing than ever, with fewer oil changes, less frequent chassis lubrication, self-adjusting brakes and triple-life mufflers.

And inside each engine, too, Ford adheres to traditional high standards of quality by specifying Perfect Circle piston rings for original equipment use. Falcon, Comet, Ford, Mercury, Thunderbird and Lincoln Continental engines utilize the performance advantages of PC ring sets, custom-engineered to each engine's specific requirements.

PERFECT CIRCLE *The Rings the "Pros" Prefer!*

PISTON RINGS · PRECISION CASTINGS · SPEEDOSTAT · ELECTRONIC PROGRAMING EQUIPMENT

Hagerstown, Indiana — Don Mills, Ontario, Canada

Agricultural Engineering

September 1961
Number 9
Volume 42

James Basselman, *Editor*

PARTNERS--ENGINEERS AND INDUSTRY

FRANK H. HAMLIN
President, Papec Machine Co., Shortsville, N. Y.

IF YOU and I are in partnership — and I think we are — we should know who the other partners are and what they have been up to lately. It might also be well for us to consider where our partnership will be in, say, ten years. Beside you and me and a few thousand other engineers and farm suppliers, just who is in our "little-ole" partnership? We have to include farmers, some teachers and a bunch of consumers, including ourselves, and then there's always government. Our "little-ole" partnership is old all right, but it is not so little. In fact, I suppose we might just as well call it the whole human race. And what a race it has suddenly become! In your own lifetime — in a paltry few seconds out of a year representing all of recorded time — you have seen more change than has occurred in all the other 31,536,000 seconds of our hypothetical year that have elapsed since man quit being a monkey. Or did he?

Whether he did or not, agricultural engineers must assume major responsibility for the rapid shift of population from rural to urban pursuits because it all stems from what you and your immediate partners have been up to lately. For thousands of years man and his progress were tied to food production by the limiting gait of the horse. The invention of the wheel helped a little, but the pace didn't change much until the gas engine came along. At that, it took another forty or fifty years before the violent changes that I am laying at your feet really got underway. Through all history, one generation simply told the next how things were, and that is pretty much how they stayed.

My chestnut mare used to be able to take me 35 miles in a day. I recently flew 3500 miles in just part of a day. I spent the next day checking on a one-man, six-ton-an-hour hay cubing operation in which not a bit of hand labor was used from field to feed bunk. I was back home again the following evening without a single saddle sore to show for my 7,000-mile jaunt. That trip set me to thinking about change — the changes in agriculture that really started popping within just the last few years. I recalled that, in a recent salute to agricultural research, it was pointed out that nearly three-quarters of today's farm crops are varieties completely unknown twenty years ago.

I then recalled that for sixty-one years my company has made stationary ensilage cutters. With only infrequent and minor changes, year after year, decade after decade, we made pretty much the same machine. We got fairly good at it. With as many as forty-odd competitors, we sold well over a hundred thousand of these cutters which put up a third to a half of the world's silage crops each year. We can't give these perfectly good machines away in this country today because no one can afford the man-hours required to handle bundles of silage corn by hand — off the ground onto the wagon and off the wagon onto the feed table. A two-row forage harvester, costing four times as much, does the job better and faster for a lot less money.

Continuing my rumination about change, it next occurred to me that almost all of our company's business next year will be accounted for by products not even in our line as recently as three years ago — hay and silage homogenizers, ton-a-minute harvesters and blowers, silo unloaders, mechanical cattle feeders, mobile feed makers, self-unloading wagons, and perhaps hay cubers. That is a rather violent change for one, small, conservative, old-time maker of stationary silo fillers!

In the past fifteen years, well over two million of our country's farms have gone out of business. Your innovations, your mechanical contraptions, your research, your teaching and extension have put them out of business. You are responsible for the economic, the political, and, most important of all, the social consequences. This precipitous drop in the number of farms has led many people to conclude that agriculture must be in a desperate situation. But in this same 15-year period virtually the same number of acres have produced a phenomenal increase in feed, food and fiber.

The census statisticians have fun calculating average farm income. They divide the total number of dollars of income received by everybody engaged to any extent at all in farming by the number of farms they counted in the last census. These so-called farms include over a million part-time operations by suburbanites and factory workers, who still love to live in the country and work a bit of land or raise a few head of livestock, and perhaps even keep a horse — bless their hearts! The result of this arithmetic, emanating from our nation's capitol, is an average farm income figure which might have looked good on a one-mule, cotton patch in Madison County, Mississippi, just after the War Between the States, but it surely doesn't now. If you and I and a northern Vermont dairyman divide the income of real farmers — by which I mean full-time operators who devote all their energy, management ability and capital to agricultural production — we begin to suspect that income per honest-to-goodness farm does not compare too unfavorably with that of the butcher, the baker and the candlestick maker.

During the past ten years, while around 1,700,000 farms were going out of business, there was a neat little increase of 64 percent in the number of farm operations grossing over $10,000 a year. The last five years alone accounted for over a million of this 1,700,000 drop in number of farms, and for quite a lot more than half of the 64 percent jump in farms doing over $10,000 a year. So it can be seen that the change to fewer and bigger farms has been accelerating. It is the kind of change that feeds on itself. As farm operations become bigger and more professional, the pressure increases on suppliers for more and better goods and services which, in turn, support still larger operations having, up to a point, still greater efficiency in the use of both labor and capital. I say "up to a point"

(Continued on page 500)

Excerpts from an address before the Annual Meeting of the American Society of Agricultural Engineers at Ames, Iowa, June 1961.

Implement Requirements in Relation to Tractor Design

Some problems for designers in attaining compatibility

W. M. Davis
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TODAY'S agricultural tractor is a complex vehicle used to propel and power a large variety of implements for agricultural production. Early tractors furnished power to implements by towing through a drawbar connection and by belt from a belt pulley. The many and varied uses made of the agricultural tractor today and its various means of providing power to implements are the results of design and development response for increased utilization of the tractor by the farmer. The implement applications, therefore, have a considerable effect on tractor design. The purpose of this paper is to discuss this relationship.

The application of implements to agricultural tractors can be broken down into five principal categories, as follows:

1 towed implements
2 hitch-mounted implements
3 integrally mounted implements
4 PTO-driven implements
5 general considerations

Each of these major items will be discussed separately and the significance of individual aspects to the successful operation and compatibility of the implement and tractor outlined.

TOWED IMPLEMENTS

Although application of power through the tractor drawbar to towed equipment is one of the oldest applications, it has been found there are still a number of particular design aspects required of the tractor to adequately provide for proper operation of towed implements. The SAE-ASAE standards outline certain drawbar dimensions, hitch pin sizes, and ratings for dynamic and static loads on the drawbar. These standards, in themselves, provide very well for interchangeabiliy of towed implements behind the tractor. Certain types of implements, however, require drawbar design and construction above and beyond what is specified in today's standards.

It is necessary to establish the proper drawbar height for a number of tillage implements. This height has been established on the basis of adequate working stability in the field with the maximum drawbar load. Proper and adequate lateral swing of the drawbar is also required on a number of implements. For instance, wide disk harrows, disk tillers, drag harrows, etc., require that the drawbar swing to provide for the tractor to turn with the implements with a minimum of effort. It has been found that facility for providing for drawbar swing has been a necessary specification of most tractors which operate towed equipment. Certain types of equipment, used primarily in the wheatland areas, require facility for additional lateral swing; this equipment and some orchard equipment require greater vertical load-carrying capacity and durability than provided for general-purpose use. The requirement has normally been met by special drawbar equipment.

PTO standards provide for a certain minimum hole size in the end of the drawbar. With the progressive increase in horsepower and drawbar capacity of tractors, it has been found that larger pin hole sizes are required in the end of the drawbar. A great deal of excessive wear can and does occur where undersize pins are used in the large holes, or where the pin size furnished in the implement is not compatible with the tractor drawbar pin hole size. The SAE-ASAE PTO standards specify a drawbar pin hole size of $^{13}/_{16}$ in. minimum; on the John Deere 4010 tractor, a $1\frac{1}{8}$-in. diameter hole is provided. Obviously, if a $\frac{3}{4}$-in. pin or bolt is dropped into the drawbar pin hole of a large tractor with large towed equipment, accelerated wear occurs and excessive looseness will result in the drawbar-to-implement fastening. It has been found necessary to establish the drawbar pin hole size in line with the drawbar pull capacity of the tractor and in turn that the implements be provided to accept the variation in pin hole sizes.

Concurrently with the foregoing, the problem exists of providing for adequate vertical angular relationship of the implement with respect to tractors. For instance, a $\frac{3}{4}$-in. pin in the $^{13}/_{16}$-in. hole of a drawbar thickness of 1 in. provides for only plus or minus $3\frac{1}{2}$ deg angularity of the implement tongue and drawbar. In turn, the same size pin in a $1\frac{1}{16}$-in. hole provides for plus or minus $13\frac{1}{2}$ deg and for plus or minus 22 deg in a $1\frac{5}{16}$-in. hole. It has been considered necessary to provide for plus or minus 30 deg of vertical angular relationship of the implement with respect to the tractor. Obviously, binding of the fastening and deflection or binding of the tractor and implement drawbars is occurring. The remedy for this particular problem for some types of implements has not been applied to date. There does exist in the industry a proposed plan to use a ball-and-socket fastening. This fastening is being sponsored by the FEI-PTO subcommittee to provide for additional oscillation and a tighter fastening between the implement and tractor, particularly in PTO applications where undesirable "chucking" of the implement with respect to the tractor occurs. The ball hitch program has also presented interesting possibilities for improving the attachability of towed equipment to the tractor and improved durability of the fastening.

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HITCH-MOUNTED IMPLEMENTS

The significance of hitch-mounted implements on agricultural tractors has been discussed before. It has been expressed previously that the operation of hitch-mounted tillage equipment was associated primarily with the smaller tractors in the two and three-bottom plow sizes. Recently the use of fully integral or semi-integral four and five-bottom plows on larger tractors has become quite common due to improved means of draft measurement and consequent depth gaging, as well as acceptance of the necessary amounts of front weight for adequate front-end stability. To illustrate how much progress has been made in the past several years, it is to be noted that a complete line of tillage equipment, including an 8-bottom fully integral plow, has been developed and is in production for the John Deere 8010 tractor.

The following factors have contributed appreciably to the extension of the operation of hitch-mounted tools to the larger sizes of tractors:

Significant improvement in tractive ability due to increased weight transfer with tillage implements

Reduced cost of the over-all tractor-implement combination

Improved transportability of the over-all tractor implement combination.

Figs. 1 and 2 are graphical presentations of the weight-transfer and wheel-slippage characteristics of two different types of tillage implements on the John Deere 3010 tractor. The performance is compared to the comparable towed implements of equivalent size in the same field conditions. When the 4010 tractor used the 5-bottom mounted plow, the weight transfer varied from 3500 to 4400 lb in the normal operating range. This was approximately 2000 lb more than on the comparable towed plow and resulted in a proportionate reduction in wheel slippage. If cast iron ballast were selling for 13¢ per pound in the field, this would amount to better than $260 worth of ballast in the field. With these favorable conditions available for certain types of tillage implements, we certainly can expect continued and expanded use of the implement hitch on all sizes of tractors.

As an example of reduced cost of the implement combination, a mounted plow plus the necessary associated equipment on the tractor, including implement hitch, front weights, etc., lists for approximately 30 percent less than a comparable towed plow with the necessary equipment on the tractor. It becomes obvious that the implement hitch offers significant functional and economic improvements over comparable towed tillage equipment and additional usage may be expected to be made in the future of the implement hitch due to these considerations.

With the significance of hitch mounted equipment on all sizes of agricultural tractors well established, it then becomes a matter of establishing proper design considerations for satisfactory acceptance and performance of a wide range of hitch-mounted equipment. The ASAE-SAE recently adopted the three-point hitch standard for both category 1 and category 2 implements. This standard is recognized as a further effort to provide for interchangeability of implements in the field from one manufacturer to another as well as between manufacturers' model sizes.

Each tractor designer has additional considerations to review in his responsibility of providing for proper compatibility of implements with tractors, such as hitch geometry, hydraulic lifting capacity, clearance for hitch-mounted implements about the tractor, and improved means of attachability.

Hitch Geometry

Fig. 3 is an elevation drawing showing the location, with respect to the tractor, of the virtual center of rotation of the hitch of the John Deere 2010, 3010 and 4010 tractors. Our experience indicates the desirability of locating the virtual center of rotation in this area as a suitable answer to the dual problem of providing for as near a parallel lift as possible, which would locate the virtual center at infinity, and of providing the virtual center near the rear axle to provide for best hill and swale operation and transport clearance of long implements. Standard conditions are used for the comparison, using a plow operating at 8 in. depth with the right-hand drive wheel in the furrow. Location of the virtual center of rotation in the plan view affects contour and hillside performance and has been discussed in a previous paper (1)*.

Hydraulic Lifting Capacity

A study of available lifting effort at the ends of the draft links will enable the designer to appraise the basic

*Numbers in parentheses refer to the appended references.

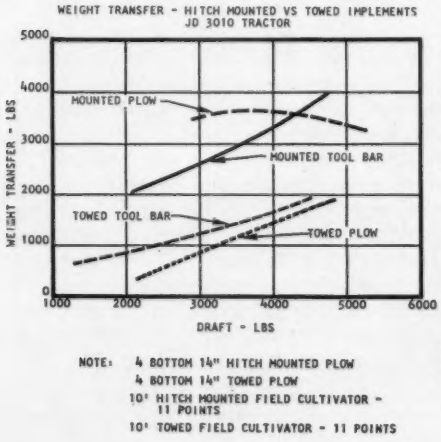
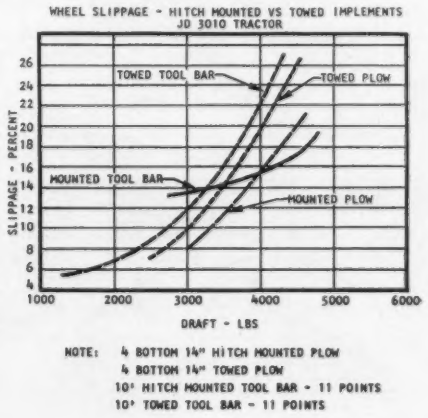

WEIGHT TRANSFER - HITCH MOUNTED VS TOWED IMPLEMENTS
JD 3010 TRACTOR
WEIGHT TRANSFER - LBS
DRAFT - LBS
MOUNTED PLOW
MOUNTED TOOL BAR
TOWED TOOL BAR
TOWED PLOW
NOTE: 4 BOTTOM 14" HITCH MOUNTED PLOW
4 BOTTOM 14" TOWED PLOW
10' HITCH MOUNTED FIELD CULTIVATOR - 11 POINTS
10' TOWED FIELD CULTIVATOR - 11 POINTS

Fig. 1 *(Left)* Graphical representation of weight-transfer characteristics of hitch-mounted vs. towed implements on the John Deere 3010 tractor

Fig. 2 *(Right)* Graphical representation of wheel-slippage characteristics of hitch-mounted vs. towed implements on the John Deere 3010 tractor


WHEEL SLIPPAGE - HITCH MOUNTED VS TOWED IMPLEMENTS
JD 3010 TRACTOR
SLIPPAGE - PERCENT
DRAFT - LBS
TOWED TOOL BAR
TOWED PLOW
MOUNTED TOOL BAR
MOUNTED PLOW
NOTE: 4 BOTTOM 14" HITCH MOUNTED PLOW
4 BOTTOM 14" TOWED PLOW
10' HITCH MOUNTED TOOL BAR - 11 POINTS
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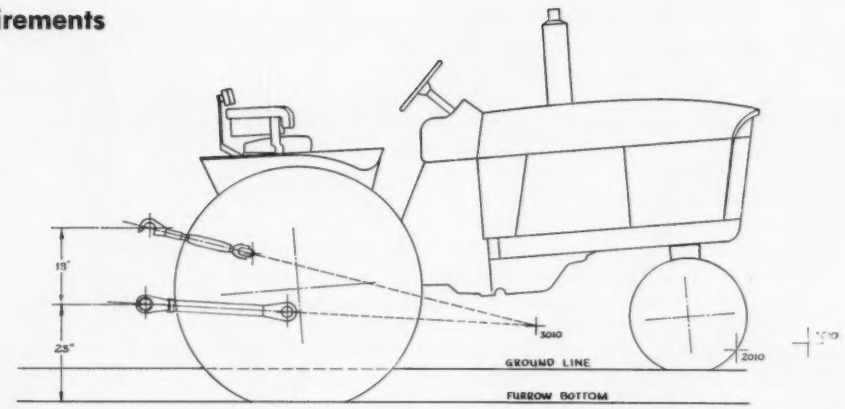

Fig. 3 Location of center of rotation of implement hitch

lifting capacity of the rockshaft and efficiency of the lifting-mechanism geometry. A comparison of the lifting effort at the implement center of gravity 36 in. behind the draft link provides an appraisal of the entire geometry of the hitch. The available lifting effort is used to overcome: *(a)* the implement weight, *(b)* the inertia effects of lifting the implement, *(c)* soil reaction, and *(d)* any friction in the system. Fig. 5 shows information for the 2010, 3010 and 4010 tractors.

Because of the rotational geometry of the lifting mechanism, there will normally be a peak on the curve of the lifting effort. It is desirable to locate the high point of the curve at the point of rockshaft rotation where tillage implements normally emerge from the ground and continue over as wide a range of rotation as possible. The curve falls off somewhat at the top and bottom of the rockshaft rotation as it has been found that the least effort is required at those points of lift cycle.

Clearance for Hitch-Mounted Implements

The SAE-ASAE standard provides for an arc of 18 in. fore-and-aft clearance ahead of the hitch balls and inside the draft links for implement space. It also provides for an 18 to 21-in. dimension from the end of the PTO shaft to the centerline of the hitch balls. There also are certain prescribed clearances of the hitch with the outside diameter of the tires. These dimensions aid in moving machine elements closer to the tractor as well as moving the center of gravity of the implement closer to the center line of the axle housing to improve implement performance and tractor stability. The tractor designer has to walk a rather narrow line in order to maintain proper drawbar to tire outside dimension, proper three-point hitch clearance dimensions and to have adequate drawbar strength for the prescribed static and dynamic loads as shown in the standards.

The tractor designer must also recognize additional clearance problems beyond what is shown in the standards. For instance, certain implements such as bedders and planters have facility to drive planting and/or fertilizer mechanisms from the tractor axles and frequently provide for depth control by levers which project forward of the implement. The clearance for the front coulter on moldboard plows has always been a problem, particularly as the plow has been moved closer to the rear of the tractor. In some instances, the coulter support comes very close to the fenders on certain models of tractors. The facilities to limit sway of the hitch mechanism and the permissible sway in the transport position affect implement clearance in the working position as well as in the transport position.

Improved Means of Attachability

The size of implements used on implement hitches has grown progressively since the introduction of the initial three-point hitch. The requirement for reduced expenditure of energy and of the time to make the attachment of the heavier implements has become increasingly important. This has presented a challenging problem to the tractor designer. Today practically every tractor manufacturer has some means of telescoping, folding, or articulating the draft links in the interest of having additional latitude in the necessary lateral and fore-and-aft positioning of the tractor with respect to

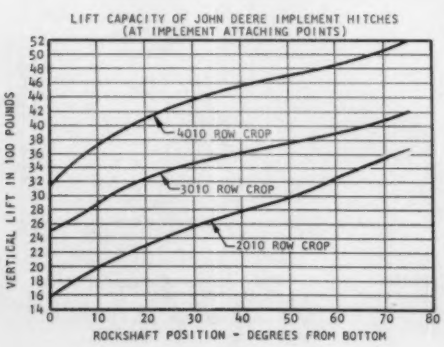
LIFT CAPACITY OF JOHN DEERE IMPLEMENT HITCHES
(AT IMPLEMENT ATTACHING POINTS)
VERTICAL LIFT IN 100 POUNDS
ROCKSHAFT POSITION - DEGREES FROM BOTTOM
4010 ROW CROP
3010 ROW CROP
2010 ROW CROP

Fig. 4 *(Left)* Lifting effort available at implement hitch on the John Deere 2010, 3010 and 4010 tractors

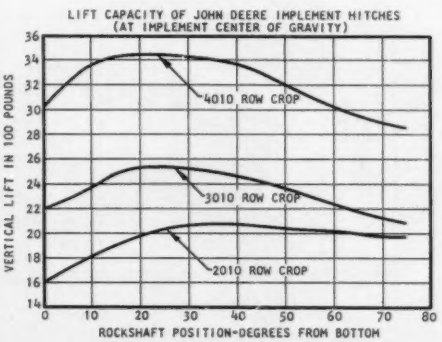
LIFT CAPACITY OF JOHN DEERE IMPLEMENT HITCHES
(AT IMPLEMENT CENTER OF GRAVITY)
VERTICAL LIFT IN 100 POUNDS
ROCKSHAFT POSITION-DEGREES FROM BOTTOM
4010 ROW CROP
3010 ROW CROP
2010 ROW CROP
NOTE: IMPLEMENT CENTER OF GRAVITY ASSUMED TO BE AT A POINT 36 INCHES BEHIND THE IMPLEMENT ATTACHING POINTS

Fig. 5 *(Right)* Lifting effort available at implement center of gravity of the 2010, 3010 and 4010 John Deere tractors. (Note: The implement center of gravity is assumed to be at a point 36 in. behind the implement attaching points)

the implement to avoid having to move the implement. Certain designs lend themselves very readily to making the complete attachment to the implement from the tractor seat without the operator having to dismount from the tractor. The Deere approach to this problem has been to retain the standard three-point hitch dimension, thereby recognizing the industry standard, and to attach an intermediate coupler to the three links of the standard category 2 hitch. This adaptor or coupler can then be attached directly to the implements. A similar attachment can still be made by one man to the largest equipment used on the 8010 tractor (2).

Only minor modifications normally need to be made to the design of three-point hitch implements, these being primarily of providing for an inverted V configuration of the mast, in which the hook of the coupler may be engaged and provision of a pin in the mast of the proper pin height above the implement. The implements still meet the industry standard. The adaptors used on the implement fit on the standard category 2 implement hitch pins. A wide number of implements in the Deere line have been adapted to the quick coupler.

The ability to couple and uncouple from a heavy hitch-mounted implement is most demonstratable and this type demonstration is received warmly by the farm trade. The use of such means has basic significance in *(a)* improved safety in making attachment, *(b)* ease of effort of attachability, and *(c)* attachment is by one man only. Today people of varying degrees of physical capability, including women, children and older people, operate our tractors; therefore, the ability of one person to couple to the implement easily without involving a second person to manipulate the hitch links has numerous operational and safety advantages. Since one person can complete the attachment without dismounting and attempting to shove tractor or implement, the degree of safety is greatly improved. Certainly we cannot overlook any measure today which improves safety in our industry.

INTEGRAL EQUIPMENT

A wide variety of today's implements are attached integrally to the front, the rear, or a combination of locations on the tractor. Implement attachment points on a tractor serve as physical means to attach the implement to the tractor and provide structural support of the implement. In some instances, the implement hitch or parts of the implement hitch are used as integral implement attachment points.

There is considerable uniformity in the spacing of holes along the side of the tractor frame as well as at the front of the tractor. The rear axle housings on all three sizes of tractors are of uniform section; locating slot locations and dimensions are uniform and provide equivalent means of fastening. The similarity of implement attachment points and dimensions on different tractor model sizes permits increased freedom of interchangeability of implements. This has considerable benefit in the reduction of the number of implements or combinations of implement bundles which must be warehoused and stocked at the dealer level.

The number of attaching points alone is not the only criteria for adequate attachment of integral implements. It is necessary to have implement attachment points in an area where they are available for proper structural support and attachment of the implement and that the points have adequate strength to withstand the loads imposed by the implements. The implement attachment points on the front of the tractor at the front grille or front plate, as well as those on the engine, serve very well to truss or brace wide implements such as bedders, cultivators, culta-carriers, etc., without auxiliary bracing means as a part of the implement. The use of auxiliary points at the top of the engine serve to support such equipment as heavy fertilizing equipment and other types of equipment so that auxiliary braces do not have to be provided as a part of the implement. Suitable means to attach to the axle housing permit adequate structural support for loaders, corn pickers, beet harvesters, etc.

Provision of adequate clearance about the tractor for implement mounting and operation is an ever-present problem for the tractor designer. Cartoons have been drawn comparing the implement designer's concept of how a tractor should be built with the tractor designer's concept of how a tractor should be built. The tractor must have styling and appearance which appeals to users but be functional in nature. The provision of adequate working clearance beneath the front section of the tractor has always been a problem so that cultivator elements, bedder bottoms, and other working elements will have adequate working and transport clearance. Perhaps the implement designer's concept of how clearance should be provided would be the most advantageous, however, in the interest of tractor functional characteristics as well as tractor stability, the amount of clearance available beneath the so-called belly of the tractor must of necessity be a compromise.

The general outline of the tractor should be free of projections and protuberances which require special implement design. The Deere line of 2010, 3010 and 4010 tractors has a standard frame width and nearly uniform hood width with no significant elements projecting outside these points so that there is good visibility and adequate room for cultivators, corn pickers, cotton strippers, etc., at the front of the tractor. Adequate clearance in the area of the rear axle housings is necessary not only for clearance of elements which must mount beneath the axle housing, such as cotton strippers and beet harvesters, but for crop clearance during crop cultivation. A clear silhouette in this area has not only provided for improved crop clearance but has made it considerably easier to mount implement elements by the use of a uniform section which facilitates clamping or bolting.

The use of optional equipment such as various muffler and exhaust systems, starting aids, wheel equipment, etc., also have significant effect on implement clearances and must be recognized in the tractor design program.

A number of harvesting machines, such as corn pickers, cotton harvesters and beet harvesters are mounted directly on the tractor and derive their power from sprockets or sheaves mounted on the PTO shaft. Attachment points are required in this area to mount the drives and clearance must be provided for the drive mechanism. It is to be noted that with the shortening of the available spline length of the 1000 rpm PTO shaft, it is all the more essential to have clearance in the PTO area for the drive so that the overhang of the sprockets or V-belt sheaves can be reduced to the minimum.

Today a number of harvesting machines which are propelled and powered by tractors are also being duplicated in self-propelled versions. The self-propelled units have proved to be justified economically and efficiencywise on

. . . Implement Requirements

many farms. However, one of the problems in financing of agricultural operations today is the farmers' tendency to overcapitalize in machinery. Part of his reasons for buying self-propelled equipment in lieu of equipment propelled by his agricultural tractor arise from the time and effort required in making the installation of the implement. The required effort varies all the way from making the simple pin and PTO hookup of a combine to the rather lengthy time it takes to install a corn picker or cotton harvester or other types of complicated harvesting equipment which envelop the tractor. Implement and tractor designers must continue their work to further facilitate the matter of installing and removing this type of equipment. Perhaps added use of the implement hitch as a means of both installing and mounting the equipment justifies further investigation. Development of simpler means of making the attachments, reduction in physical effort and reduction in preparation time of the tractor are significant factors which will permit greater utilization of the tractors the year around by the farmer for his agricultural operations and a reduction in his capital expenditure requirements.

PTO-DRIVEN IMPLEMENTS

There has been co-operative work in the industry for many years regarding the standardization of PTO drives and performance criteria for PTO drives. Even today considerable work remains to be done.

Considerable study is being made of the history of PTO operation with respect to the over-all pattern of use as far as loads imposed, percentage of time at maximum load, frequency and amount of load of reversals, amount of time spent in turns where torque peaks are high, etc., in order to evolve more accurate design criteria for future designs. A better appreciation of the history of PTO usage should contribute to improved durability, possible reduction in cost of the PTO drive unit, a shortening of the development time for the PTO drive, and better performance and durability in the hands of the farmer.

Increases in the number of cylinders used in the power plant of the tractor, and the increase in horsepower of the tractor have imposed new problems on the tractor designer not previously experienced. SAE Recommended Practice specifies the instantaneous operation loads should not exceed 7500 lb-in. This is 119.2 hp when power transmission is absolutely uniform at 1000 rpm and 64.3 at 540 rpm. With today's tractors it is readily seen that on certain models of tractors this value is already exceeded when implements are driven at 540 rpm. The peak to valley torque fluctuations in a typical implement application can generally be expected to be 50 percent of the average torque transmitted. This means that typically an average of 42.8 hp can be transmitted at 540 rpm and 79.5 hp at 1,000 rpm. With the progression of tractor horsepower and power requirements of PTO-driven machines, it is obvious that the 1000-rpm speed will be required to properly transmit the power within the specified limits. New machines being created should, therefore, provide for the efficient use of the power at 1,000-rpm speed.

The industry must recognize the requirement for additional average torque value specifications for the PTO drive. An appreciation of the type of service to which the tractor is imposed, as well as improved materials and heat treatments, can certainly contribute to an increase in the ratings. There certainly must already be some latitude in this matter as some tractors exceed the 7500 in.-lb today at the 540 rpm speed. By careful choice of the design of parts and flexibility in the power line of the implement, it may be possible to reduce torsional loads created by high-frequency torsional vibration to a value somewhat less than the 50 percent now prevalent.

The use of the 1,000-rpm PTO has imposed certain physical problems on both the implement and tractor designer not previously experienced. Some difficulty has been experienced in adequately retaining sprockets and sheaves on the PTO shaft due to the side loads they impose on the shaft. These problems arise from a change in length of the involute spline as compared to the straight-sided spline. Generally it has been found that by careful attention to the structure of the sprocket or sheave which clamps to the spline and the material used in the clamping means, the maximum side loads, as established by the "Recommended Practice for Agricultural Implements," may be successfully transmitted.

The combination of the PTO and implement hitches dictates the physical dimensions at the rear end of the tractors. The geometry of the hitch and the position of the power line on the implement significantly affect the ability to provide adequate telescoping without the drive line pulling apart or going to a solid position at the other extreme. It is indicated that a reduction in the 18 to 21-in. dimension from the end of the PTO to the hitch balls to a closer tolerance may be in order. However, this measure alone will not correct all the problems associated with this type of implement usage. Careful study of the vertical oscillation of PTO-driven implements throughout the lift range of the hitch is necessary to make sure that there is adequate clearance of the PTO drive line with tractor elements.

A brief word should be said concerning the attachability of the PTO drive itself to the tractor. The prior discussion has been related to reduction in the effort of the operator in attaching his heavy equipment; however, further work is justified to improve the attachment of the PTO drive to the tractor PTO shaft. We have merely to look at the amount of battering on the universal joints of machines in use as a result of operators driving the connection on and off the PTO spline to realize the requirement for improved attachment of the universal joint to the PTO. Eventually we may hope for a fastening which in itself is "quik-tach". This is a fruitful field of exploration. Since this effort appears to be of a long range nature, it appears that the efforts to further reduce the primary physical effort of making the attachment of the existing drives to the tractor should proceed forthwith.

The use of the belt pulley as a power outlet of the tractor has steadily diminished to the point that today the belt pulley attachment is normally sold as a special equipment item at extra cost. The simplified and easier means of attachment of the PTO shaft have contributed appreciably to the replacement of belt power to many machines. The use of the 1,000-rpm PTO shaft speed can be expected to make it still more convenient and economical to furnish power to machines previously belt driven.

General

Previous discussion has been devoted to the integration of tractor design with implement requirements. However, in the design of the tractor alone, a great deal of consideration must be given to its eventual application to general usage. As an example, the operator must have adequate view of the working elements on the machine whether they be front mounted, side mounted or rear mounted, which affects operator location. Placement of controls for the operator must be such that they satisfy the majority of the operations associated with the tractor. There obviously always are instances where controls should be located in an alternate location for certain specialized operations, but the tractor designer needs to give considerable attention to the principal uses of his tractor to indicate the logical location of the controls. A considerable degree of uniformity has been obtained on the 2010, 3010 and 4010 Deere tractors in this respect and has been extended to the 8010 as well.

There have been various studies made of configuration of the tractors and of relative placement of the major tractor components in the tractor chassis. At first, it may be thought that this is strictly a tractor design requirement, but these considerations are also dictated by implement clearances. Implement requirements and applications influence such items as crop clearance, cleanliness of the exterior, wheelbase and width of tractor, horsepower-to-weight ratio, weight distribution, and location of air intakes for the engine and cooling system. Admittedly, every design represents some sort of a compromise, but we are all aware of the fact that tractors can never be made as long, as wide or as low as the tractor designer would like to have them because the tractor must simply provide for implement elements for which the tractor is intended. It becomes the tractor designer's responsibility to "shoe horn" all of the necessary tractor components into the minimum envelope, the most applicable configuration and silhouette and then provide for adequate functioning, reliability, engine cooling, etc.

Summary

The purpose of this paper has been to point out many of the problems associated with providing agricultural tractors for usage with implements. Several general conclusions can be drawn from this discussion, as follows:

1 This paper points out a large number of considerations indicating that an intimate relationship must exist between implement requirements and tractor design.

2 The use of established industry tractor and implement standards has and will continue to furnish general "guide lines" for the tractor designer to provide for interchangeability of implements in the field and for compatibility of implement and tractor combination. Several items have been reviewed requiring further study.

3 The tractor designer must be well enough aware of implement requirements together with guidance furnished by industry standards so that he will be able to provide a tractor design requiring a minimum of subsequent modification for proper implement operation.

4 Improved techniques in studying the total tractor history are indicated. This type of program has promise in establishing better testing parameters, possible reduction in cost due to a better choice of material, sizes, etc., reduced development and testing time and improved reliability and durability.

5 The tractor designer can enhance the possibility of greater interchangeability of implements (and consequent reduction in distribution and warehousing costs) by providing a pattern of similar implement attachment dimensions and uniform clearances on the tractor throughout tractor model sizes.

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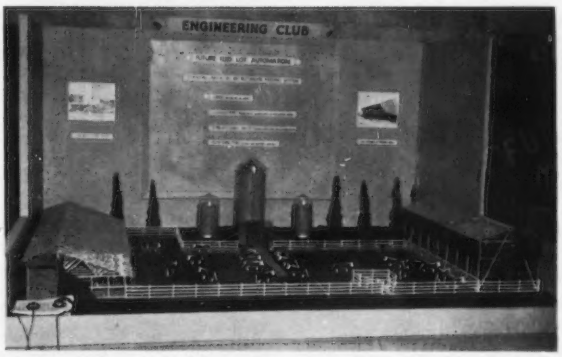
Ontario Student Branch Wins Coveted Trophy



THE Ontario ASAE Student Branch, Ontario Agricultural College, in competition with 14 other clubs, this spring won first prize for the best exhibit during the annual College Royal Stock Show and Fair. The award consists of the Wade Toole Memorial Cane trophy, a blue ribbon and a check for $25.00. The winning entry, shown above, consisted of a model barnyard illustrating future feedlot automation for steer feeding, which was designed and built by the student branch members. It included two scale model pole barns, three storage bins, and a moving conveyor belt and augers. According to reports, the cash portion of the prize was used to help finance the club's annual Ladies Night for students and faculty members. During that evening several prizes, donated by local business men and industries, were awarded to students for best drawings, reports, and various engineering projects.

For the 1960-61 school year, Ontario had the largest ASAE Student Branch with 89 members. Their professional curriculum in agricultural engineering includes a fifth year of engineering training at the University of Toronto.

Spreading Dry Materials by Airplane

Laboratory and flight studies of distributor design

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AFTER World War II the airplane came into rather extensive use for applying agricultural materials to farm land. Statistics on aerial farm operations in the United States indicate that about 52 million acres are covered each year. The largest acreage has been for insect control, with smaller acreages for weed control, fertilization, defoliation, seeding, and other jobs. More than 800,000 hours of aircraft flying time was required to this work (1)*.

Several students and faculty at Ohio State University along with members of the Ohio Division of Aviation became interested and saw a need for research in the field of agricultural aviation. This group spent considerable time on the problem. As a result, the project reported in this paper was initiated through a grant from the Ohio Division of Aviation.

The first work on this project was concerned mostly with methods of measuring the deposits of aerially applied materials (2). In these and other studies it was observed that improvements were needed in aerial application equipment to improve the distribution pattern and control the rate of application. Most of the early equipment consisted of a hopper with a crude sliding gate over an outlet in the bottom for controlling the flow. A Venturi tube or other distributor, built from experience or by trial-and-error was attached below this opening for spreading the material. The resulting swath was usually far from ideal.

The work reported in this paper was directed towards the development of a basis for the design of a distributor for applying dry material such as seeds, fertilizers, dusts, and granular materials.

Both wind tunnel and flight studies were conducted on the ram-air or Venturi type distributor. The work began with a wind tunnel study using a test distributor which was adjustable in opening, outlet, and throat size. Determinations were made of the effects these variables had on the distributor capacities. A flight study followed, using a test distributor to determine additional distributor design factors which contribute to a wide swath. Tests were then conducted with a complete distributor to determine and correlate factors which produce a desirable distribution pattern and swath width.

The function of this type of distributor is to give the material being applied sufficient energy and proper direction to produce a satisfactory swath width and distribution pattern. Some of the factors that affect the swath width and distribution pattern include natural air currents (thermals, cross winds, etc.) air currents caused by the aircraft itself (propwash, wing vortexes, etc.), aircraft speed and altitude, type of material being applied, application rate, and the distributor size and configuration.

Wind Tunnel Studies

The wind tunnel (Fig. 1) was used in order to determine some of the characteristics such as the amount of energy available from the ram air, the effects of constrictions at the throat (Venturi shapes), distributor size (in cross-sectional area), material type and dispensing rate, and air speed.

Some calculations were first made to try to estimate how large a distributor might have to be to apply a certain amount of material per acre. A wind tunnel, a test section of an adjustable Venturi-type distributor, and air-flow measuring devices were designed and built. A metering device previously developed was used to control the flow of material into the distributor test section (3).

The distributor section was 6 in. wide, 3 ft long, and was adjustable in depth from 3.5 to 9.5 in. It had removable inserts 1, 1½, 2, 2½, and 3 in. thick, to vary the constriction of the Venturi, and had straight clear plastic sides. It was possible to vary the amount of constriction from zero to a ratio of the opening size over the throat size of five to one.

Pitot-static tubes and differential manometers were used to measure the air velocity and static pressure. A Pitot-static tube was placed in each of the following locations: in front

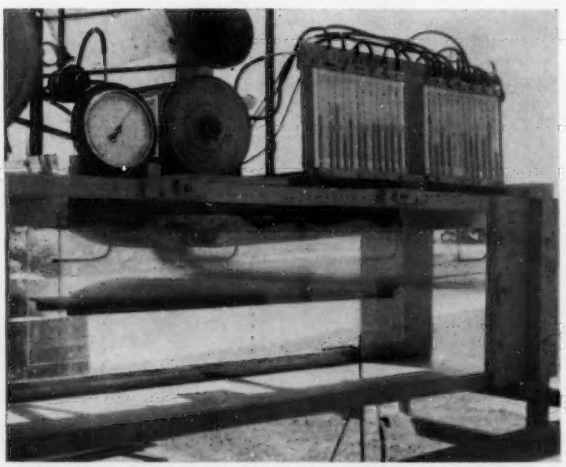

Fig. 1 Wind tunnel and adjustable test distributor used in the Ohio AES studies

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*Numbers in parentheses refer to the appended references.

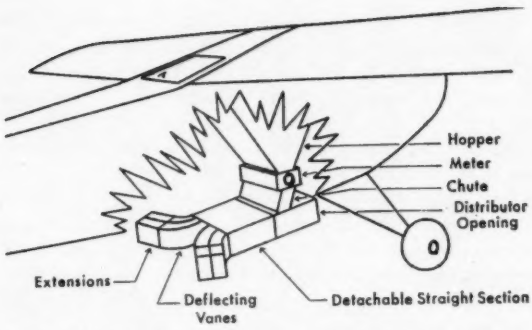

Fig. 2 Schematic sketch of location of equipment in the airplane and an example of the test distributor

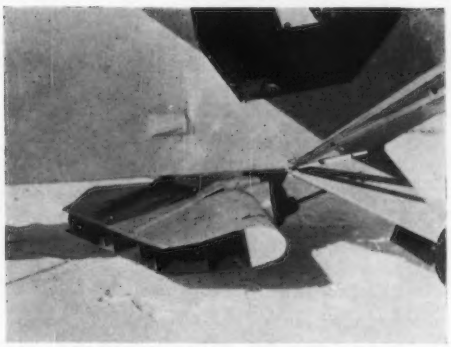

Fig. 3 Complete distributor showing placement of vanes of the outlet and streamlined leading edge added to reduce drag and wind buffeting

of the distributor, just inside the opening, in the throat, near the outlet, behind, and below the distributor.

Tests were made using the various distributor inserts, opening sizes (depth of distributor), air speeds and material rates with wheat as the material. Some runs were also made with several types of fertilizer and dust. Difficulty was encountered with the finely ground fertilizers and dust plugging the pitot tubes; however, if they were blown out before each run, they functioned fairly well.

Following the above tests a series of runs were made taking high-speed movies (1800 frames per second) in an attempt to actually measure the particle velocities in the distributor test section and provide a means of studying the distributor action. The wind tunnel data, used for several of the graphs in this paper, are from this series of runs.

Estimating the Swath Width

In order to estimate what swath width would result from the lateral velocity given to the particles by the distributor, more information was needed. The drag, vertical displacement, and particle travel of ⅛-in.-diameter vetch seeds was calculated (4).

Since wheat was used in the wind tunnel tests, it was decided to determine experimentally how far it would travel by throwing kernels at various speeds from various heights. This also served to check the calculated data. The wheat was thrown by placing it in a drum rotating at a known speed and then releasing the particles. The horizontal distance traveled was then doubled to arrive at an estimated swath width. These calculations and experiments were conducted in still air and the results would no doubt be somewhat different if the particles were thrown from a moving aircraft because of the forward motion and the currents created by the aircraft.

Flight Studies Using A Test Distributor

A test distributor (Figs. 2 and 7) was then built for actual flight studies. It consisted of a detachable straight section immediately behind the chute, three sets of detachable deflecting vanes, and two sets of extensions for attachment on the outboard end of the deflecting vanes. Also two outlet angles were used with one set of the deflecting vanes.

It was possible to study the variables of distributor length, radius and location of deflecting vanes, width at the outlet, and the outlet angle. The effects of varying the application rate and altitude were also observed. A granular fertilizer and 30-60 mesh granular clay (insecticide base) were the materials applied during these tests.

In order to determine the effects of these variables, the deposits were measured to obtain the application rate, swath distribution, and swath width. The air speed and static pressures were measured at two locations in the distributor and the speed was measured in front of the distributor and on the wing strut. The aircraft altitude (wheel height) as well as wind speed and direction were measured. The material dispensing rate was controlled with a vaned rotor metering device driven from the aircraft engine through a variable-speed hydraulic drive.

The deposits were measured by collecting the material in three-foot square, canvas-bottom trays, placed 6 ft center to center across the flight path. The material in each tray was then measured in a tapered clear plastic tube which had

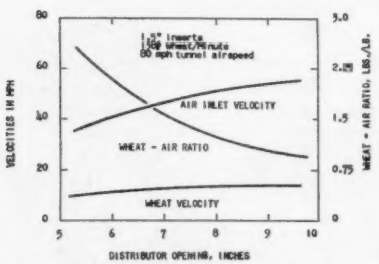

Fig. 4 Air inlet velocity, wheat outlet velocity, and wheat-air ratio as influenced by the distributor opening size (in depth)

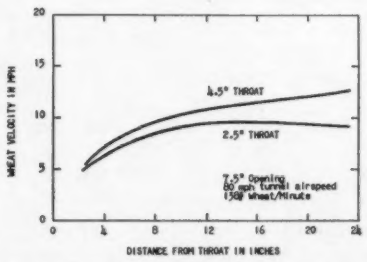

Fig. 5 Wheat particle velocity vs. the distance from the throat. (This gives a cross section of how the particles accelerated as they were carried from the distributor throat to the outlet)

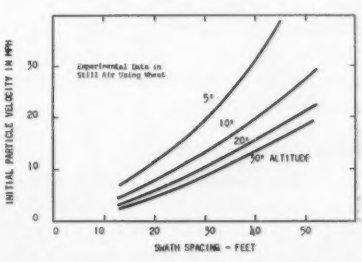

Fig. 6 Estimated swath widths that would be produced at several flight altitudes as influenced by the lateral velocity of wheat grain

been calibrated for each material. The plane altitude was determined by the use of a triangulation sight. The wind direction and speed were obtained with a combination wind vane and swinging vane anemometer.

The equipment was installed on an 85-hp Piper J-3. In general, the test flights were made with the plane directed over the measuring trays into the wind at an altitude of 25 ft and air speed of 70 to 75 mph.

Complete Distributor Built

A complete distributor (Fig. 3) was designed and built in order to coordinate the information gained from the test distributor studies and to obtain more information on factors affecting the distribution pattern. The distributor is 8 in. deep by 22 in. wide at the inlet, 31 in. long, and approximately 6 ft wide by 4 in. deep at the outlet. The deflecting vanes are adjustable to some extent. An air foil was attached to the leading edge of the outside vanes to help reduce drag and buffeting. A device with a variable opening was attached at the distributor inlet which made it possible to vary the opening from 4 to 10 in. in depth. Areas were blanked off at the distributor outlet making the cross-sectional area approximately constant from front to back, except for the adjustable opening.

Tests were conducted with this distributor in a manner similar to those conducted with the test distributor. Wheat and two coarser sizes of granular clay were used in addition to the granular fertilizer and 30 to 60 mesh clay used with the test distributor.

RESULTS

Probably one of the main principles in the design of the ram air distributor, is that the particles must leave the distributor at a high velocity. By so doing, better lateral and linear distribution can be obtained, also the material will not settle out and lay in the bottom of the distributor. Of course, the particles will also have to be directed in the proper direction by the distributor.

One of the undesirable effects of using ram air for accelerating the particles is the fact that as the material dispensing rate is increased, the amount of energy available to accelerate a particle decreases. This occurs because the amount of air flowing through the distributor is reduced due to the additional drag on the material while the total air pressure stays about the same. Thus the air velocity, effective in accelerating the material, decreases as the material flow rate increases. The results of this were evident in the wind tunnel tests as the dispensing rate was increased the particle velocity at the outlet decreased and in the flight tests the swath width decreased as the application rate was increased (Figs. 8 and 11).

Wind-Tunnel Studies

It was found that, as the cross-sectional area of the throat was reduced to one-half of the inlet area or less, the velocity of the wheat leaving the outlet decreased considerably (Fig. 5). The wheat velocity also decreased when the cross-sectional area distributor was decreased (Fig. 4), when the material flow rate was increased, or when the air speed was decreased. With no constriction (Venturi) at the throat as compared to a moderate one (down to approximately two-thirds of the inlet area), there was very little difference in the velocity of the wheat at the outlet. A moderate amount of Venturi may help the flow of material from the hopper in many cases where a positive-type metering device is not being used.

At slow air speeds and with small openings or throat sizes it was possible to completely choke the distributor. At medium air speeds the wheat or granular fertilizer flowed out in a layer on the bottom of the distributor. At the higher air speeds and with the larger openings and throat sizes wheat or granular fertilizer was carried in the airstream. Finely ground materials were generally carried in the airstream.

During the wind tunnel tests the wheat velocity at the outlet was in most cases approximately one-fourth that of the air velocity (Fig. 4).

Thrower Studies

The information gained from projecting the wheat particles at various velocities showed that wheat with a lateral velocity of 12 mph would give an estimated 35-ft swath from a 25-ft altitude (Fig. 6). Thus, if the distributor projected the wheat at a 60-deg angle, the actual velocity would have to be approximately 15 mph. This is about the maximum obtained, at 140 lb of wheat per minute, during the wind tunnel tests. This would permit an application rate of approximately 100 lb per acre when using a 24-in. wide distributor (at the throat) at 75 mph.

It should be noted that these experiments to estimate swath width were conducted in still air. The results would possibly be different if the particles were thrown from a moving aircraft because of the forward motion and the air currents created by the aircraft and distributor. Apparently the forward motion would tend to decrease the swath width because of an increased drag on the particle, while the air currents would tend to increase the swath width.

From this information then, in order to obtain a wide swath at a high application rate of material such as wheat, it would appear necessary to use a large distributor (in cross-sectional area at least) with a moderate or no constriction at the throat. A comparatively high air speed and high altitude would also help.

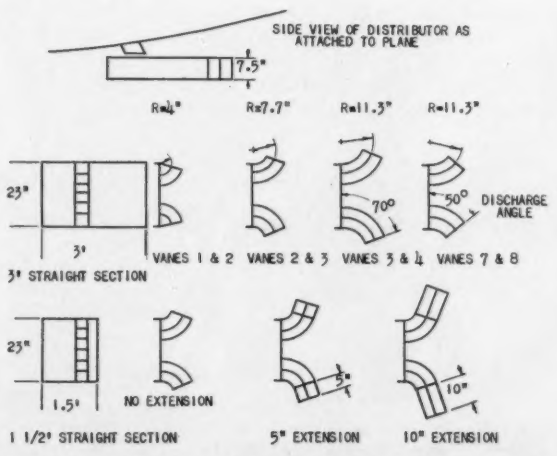

Fig. 7 Various flight-test distributor attachments or variables. The various combinations of vanes, extensions and straight sections were used

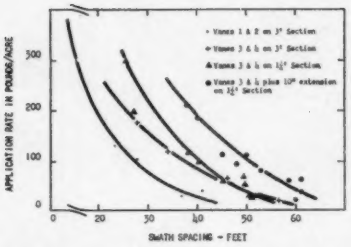

Fig. 8 Swath width vs. application rate for several configurations of the flight-test distributor when using a granular fertilizer

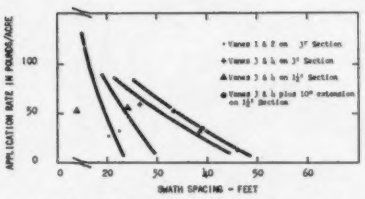

Fig. 9 Swath width vs. application rate for several configurations when using a 30-60 mesh granular clay. The swath spacing is not the extreme spread but the width that would normally be used for the most uniform over-all application

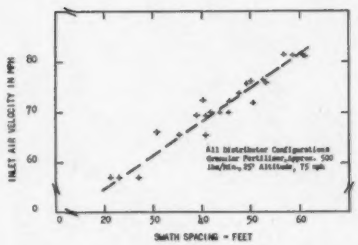

Fig. 10 Measured swath width vs. the inlet air velocity of all of the various flight-test distributor configurations

Flight Studies with Test Distributor

Using the variable test distributor, it was found that certain variables give somewhat different effects with different materials. When using granulated fertilizer the short distributor (1½-ft section) gave the widest swath, but with 30-60 mesh granular clay the long distributor (3-ft section) produced the widest swath (Figs. 8 and 9).

In general, the swath width increased as the radii of the deflecting vanes increased for both materials applied (Figs. 8 and 9). There was some decrease in swath width when going from vanes 2 and 3 to 3 and 4 with the 3-ft long section using granular fertilzer when the application rate was over 250 lb per acre. With the 1½-ft section, vanes 3 and 4 produced the widest swath in all cases.

The swath width also increased in practically all cases with an increase in the length of the extensions (Figs. 8 and 9). However, the extensions were not used with vanes 2 and 3 and 3 and 4 on the 3-ft long section because of insufficient ground clearance. The length of extension appeared to be one of the more important factors contributing to the swath width especially with low density materials such as the granular clay. In all cases the swaths were wider when using the 10-in. extensions than when no extensions were used. The 5-in. extensions gave a slightly wider swath of granular fertilizers when the application was over 250 lb per acre, but in most cases the 10 in. extensions gave a considerably wider swath. This was especially true with the 30 to 60 clay and the lower fertilizer application rates.

The 70-deg discharge angle appeared to give a wider swath than the 50-deg discharge angle although very little or no difference was observed with the granular clay. This may have been due to the variability between the limited number of passes made.

Probably the reason for the decrease in granular fertilizer swath width when using the 3-ft section; vanes 3 and 4 on the 3-ft section at high application rates; or the 10-in. extensions with vanes 3 and 4 on the 1½-ft section at high application rates, was because of the additional drag from the material being in the distributor over a longer distance. This overloaded the distributor to the point where the air flow decreased enough to cause a narrower swath to be produced.

In nearly all cases the air velocity at the distributor inlet was higher when using the distributor configurations which gave the wider swath of granular fertilizer (Fig. 10). The air velocities were not measured when using granular clay, but the same would probably be true with most of the distributor configurations used. The air velocities measured in the flight studies seems to agree quite well with what might be expected from the wind tunnel studies, in that high velocities are needed to provide a wide swath and that the air velocity in the distributor gives an indication of the distributor performance. In general, the air velocities in the vicinity of the flight test distributor were higher than those obtained in the wind tunnel. They were also considerably higher than the air speed of the airplane itself. This was because of the propwash and the aircraft configuration.

Complete Distributors Studies

Results with the complete distributor (Fig. 3) appear to agree quite well with the expectations based on the previous studies. Swath widths were about the same as the maximum swaths obtained with the test distributor. With granulated fertilizer or wheat, the swath width was approximately 50 ft at 100 lb per acre. At 20 lb of granular insecticide per acre the swath width was approximately 45 ft (Fig. 11).

Coarser granular clays, 20 to 30 and 8 to 15 mesh, appeared to give about the same pattern and swath width as the 30 to 60 mesh clay (Figs. 11 and 12).

The streamlined leading edge (Fig. 3) attached to the outside vanes of the distributor, increased the cruising speed several miles per hour and improved the flying characteristics considerably. After the streamlined leading edge was installed, no buffeting or yawing could be noticed.

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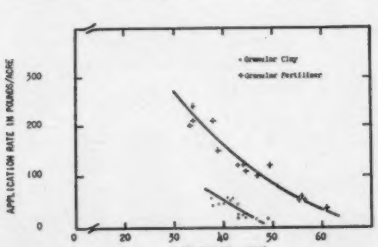

Fig. 11 *(Left)* Swath width vs. application rate for the complete distributor

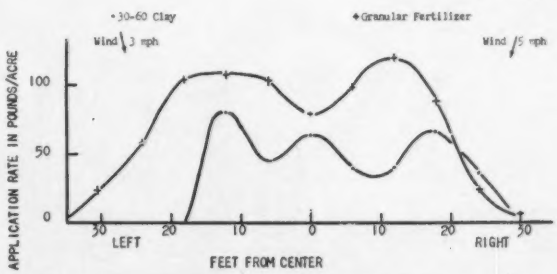

Fig. 12 Typical deposit patterns obtained with the complete distributor

Grain Drying with Supplemental Heat

Design procedure in relation to economic limitations

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Fellow ASAE

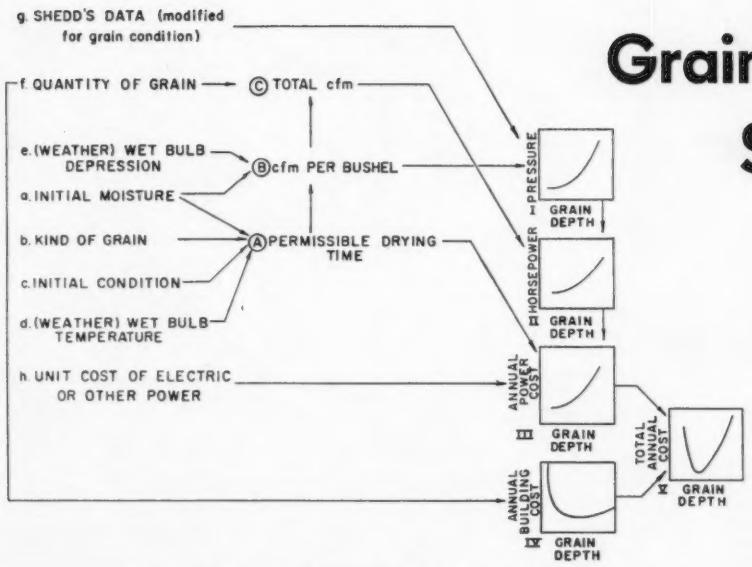

Fig. 1 Diagram of design procedure for an unheated-air drier

IT has been customary to classify grain driers as heated-air and unheated-air driers. In some ways it is more logical to describe them as fast or slow.

In fast drying practically all the heat required for vaporization is supplied from the fuel. In this kind of drier speed is necessary to make the operation economical. The sooner each batch is dried, the more grain can be put through the drier. The only way we have of substantially speeding up the moisture loss from each kernel is to raise the temperature. Fast drying is high-temperature drying. The limit of temperature is not set by the economy of the drying process but by consideration of the resultant effect of heating on grain quality.

Slow drying, on the other hand, is usually done in storage, and there is no necessity for getting the grain out of the way for another batch. In this case the only need for haste is to complete drying before spoilage results from biological activity. When using unheated air, it is most economical to take as long as possible, just so the grain does not spoil. This keeps the power requirement to a minimum.

The design of a slow-drying installation is hampered by lack of knowledge. Nevertheless there is a specific design procedure for arriving at the most economical bin dimensions, fan selection, and air-distribution system. Because of the number of conditions that cannot be evaluated satisfactorily, it is customary to short circuit formal design by applying rules of thumb and experience in laying out a drying system. Even though rules of thumb and experience may be the best guides available, their use implies that they result in the most economical layout. For this reason it may be useful to outline the design procedure implied in arriving at an in-storage drying installation for unheated air, in which the bin is filled and then dried.

Fig. 1 is a diagram of the design procedure showing the primary factors, how they combine, the resulting relationship, and the ultimate choice of a building and equipment for the case in which all the grain is put in storage at once and dried in place.

Fig. 1 shows eight primary factors, *(a)* to *(h)*. Four of these *(a, b, c,* and *d)* combine to govern the permissible time for completion of drying. The initial condition of the grain *(c)*, whether the kernels are sound or mechanically damaged, will affect the rate of deterioration. The item of weather with which we are concerned in estimating permissible drying time is the wet bulb temperature *(d)*. The temperature of the undried grain follows the wet bulb temperature closely. In general, the higher the wet bulb, the more quickly spoilage occurs. Each of the four primary factors has its effect on permissible drying time, marked *(A)* on the chart.

After estimating the permissible drying time, we move to cubic feet per minute per bushel which is *(B)* on the chart. It is derived from permissible drying time *(A)*, initial moisture content *(a)* and wet bulb depression *(e)*.

The total quantity of grain *(f)* and the cubic feet per minute (cfm) per bushel *(B)* combine to give an estimate of the total cubic feet per minute (cfm) required *(C)*.

The next step is to find the relation between air pressure and depth of grain. This relation is established by combining the cfm per bushel *(B)* and Shedd's data for grains *(g)*. This relation is indicated diagrammatically in small rectangle (I). In using Shedd's data it is necessary to make allowance for the condition of the grain, because for the most part Shedd's data is for clean grain.

The depth-pressure relation and the total cfm requirement combine to give the relation between depth and horsepower required, rectangle (II). This is the point for selection of specific fans, several of which may need to be considered in the problem. Or it may be assumed at this point

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that the fan efficiency will be, say, 50 percent, in which case the fan selection is deferred until the depth has been fixed.

Now the total power cost, rectangle (III), for various depths may be estimated by introducing the unit cost of power *(b)* and permissible drying time *(A)*. In this step it may be desirable to add the fixed cost of the fan and motor. Since this may or may not have a major influence on the selection of dimensions, it is not shown in the illustration.

The annual cost of the building for a given quantity of grain is a function of the grain depth as illustrated in rectangle (IV).

Finally the total annual cost as related to grain depth may be represented by rectangle (V). This final rectangle, which shows the sum of the power and building costs, is used to select the most economical grain depth.

If a duct system is used instead of a false floor, the procedure is similar but the relation in rectangle (I) is modified. The subsequent steps are the same as for design with a false floor.

Frequently the procedure shown in the chart may need to be modified for a specific case because of special considerations. The dimensions of the building may be fixed, There may be a limit on the horsepower available, or other special conditions may limit the freedom of design.

Whether the complete design procedure is followed or whether short cuts are used, when the design is completed, it usually becomes apparent that if high initial moisture is to be accommodated, the optimum depth of grain is in a building uneconomical for storage. For this reason two modifications of in-storage drying are being used: (1) layer drying and (2) supplemental heating. Used in combination, they permit more economical use of bin space and horsepower.

Layer drying means filling the bin part full at first, drying that portion, then adding more grain to be dried in turn. Several successive layers may be added, the drying in each one being completed or nearly completed before the next layer is added. This gives two advantages. First, the grain depth is held to a minimum while the lower layers are being dried, thus permitting maximum total volume of airflow for the entire drying operation. Second, the total permissible time for completing the drying is longer because the grain in each of the upper layers starts to dry soon after it is put in the bin, and the permissible drying time, *(A)* in the diagram, may be computed for each layer separately. That is, when each layer is harvested and put in the bin, the permissible drying time applies to that layer and not to the drying time for the whole bin.

Supplemental heat drying is drying in storage with the addition of a small quantity of artificial heat. This discussion will be limited to use of enough heat to raise the atmospheric temperature by not over about 20 F. The advantages of using supplemental heat for in-storage drying are that drying may be carried on continuously, regardless of atmospheric conditions, and the drying time with a given rate of airflow can be shortened.

The only purpose of supplemental heating is to improve the economy of in-storage drying. It may do so in two ways. First, in locations where the wet-bulb depression is low, or in years when it is short of the average for that location, the airflow requirement may be excessive. Supplemental heat can be used to reduce the required air volume when atmospheric conditions are limiting. Second, for high-moisture grain, such as shelled corn with 25 percent moisture or more, the grain depth that can be dried economically with unheated air is limited. Supplemental heat, in combination with scheduled layer drying, can be used to relax the depth limitation on unheated-air drying and utilize the building to better advantage. Since supplemental heat increases the wet-bulb depression, it tends to reduce the cfm per bushel requirement. However, it also increases the wet-bulb temperature, which by itself would tend to increase rather than decrease the cfm per bushel required. The net result of adding supplemental heat at a given rate of airflow is to shorten the drying period but to increase the rate of biological activity. The conditions under which the advantage of faster drying outweighs the disadvantage of faster deterioration are not known. Studies now under way should help clear this up. It seems likely that the first increments of temperature rise will give a more favorable balance than increments added when the relative humidity is low.

When air is heated 20 degrees the relative humidity is reduced to about half of its initial value. Even when the atmosphere is saturated, a temperature rise of about 10 or 12 degrees is sufficient to dry the grain to a satisfactory storage moisture. Depending on the temperature rise and the type of controls used, supplemental heating frequently results in overdrying of the grain in the lower layers. Such overdrying may or may not be desirable.

When grain is sold while having a moisture content below the maximum for the grade, the seller usually takes a loss. Grain is sold on a basis of total weight. The drier it is, the less weight a given quantity of grain has. Even if the grain is to be fed on the farm, severe overdrying may result in a loss. Animals cannot eat dry hard grain easily and are likely to waste it, even though it may have lost none of its intrinsic value. If overdried grain to be fed is permitted to regain moisture from the atmosphere before feeding, it becomes more palatable. There is no evidence that grain dried to low levels of moisture is inferior for feeding provided the moisture content is not too low at the time of feeding.

Insects, too, have difficulty living on grain that is very dry. In areas where storage insects are a serious problem, they can be controlled by overdrying the grain. In the South it is a good practice to dry grain to 8 to 10 percent moisture and hold it in this condition during storage. Before using it, the moisture is brought up to a suitable level by operating the drying fan during periods of high humidity. The re-expansion of the grain on account of the moisture absorption causes a structural problem which was discussed at the 1959 ASAE winter meeting by R. A. Saul, USDA agricultural engineer at Ames, Iowa.

Overdrying, such as occurs with temperature rises up to 20 F, can be used to facilitate the drying process. If, during the early part of the drying period, the lower layers of grain are dried to substantially below the desired final moisture content, they form what might be considered a reservoir of drying capacity. Later on, if the humidity is high, the air passing through this dry grain will lose moisture to it and will have increased capacity for drying the upper layers as a result.

The rate at which moisture is carried away depends on the volume of airflow and the wet-bulb depression. As be-

(Continued on page 499)

Pulsating Pressures in an Internal-Combustion Engine Induction System

Characteristics of engine intake air column show marked effect on power output in addition to air cleaner and carburetor performance

J. C. McMunn, R. R. Yoerger and J. A. Weber
Assoc. Member ASAE *Member ASAE* *Member ASAE*

THIS paper presents the findings of an experimental investigation of the magnitude, frequency, and wave shape of pulsating pressures occurring in the induction system of a spark-ignition tractor engine. The effect of intake pipe length on air flow in the intake system, on engine performance with oil bath and dry-type air cleaners and on power output at several engine speeds under wide-open throttle operation is presented.

The inward flow of air into an internal-combustion engine is not a steady flow, but is unsteady due to the periodic opening and closing of the intake valves and to the motion of the piston. Numerous investigations during the past forty years have been made to find ways of increasing engine power utilizing the inward unsteady air flow (2, 3, 4)*. Most of these research efforts have been theoretical and experimental studies on single cylinder engines. In general, these studies have shown there are several pipe lengths which can give sizeable power increases above that obtained with no pipe at a given engine speed.

A literature review will show that very little attention has been directed toward the effect of pulsating air flow on carburetor and air cleaner performance. To the knowledge of the authors, most air cleaner and carburetor manufacturers have in the past performed their cleaner efficiency tests and determined carburetor discharge characteristics primarily with a steady air flow.

Dry-type air cleaner studies at the University of Illinois, involving both bench and engine tests, have confirmed that pulsating air flow does result in lower cleaning efficiencies than does a steady air flow (1). The pulsating air flow has some influence on the cleaner in permitting the dust to pass. Pulsating air flow duplicating the frequency and amplitude of the engine application should be used on bench tests to subject the cleaner to realistic conditions. Many companies are attempting to use pulsating air flow even though not included in the present Society of Automotive Air Cleaner Test Code.

Experimental Investigation

The engine used for this investigation was a 3½ x 4¼ four-cycle, four-cylinder, spark-ignition governed engine typical of the type found in farm tractors. Tests were conducted at constant engine speed and wide open throttle. Pipe length preceding the carburetor was varied.

Tests were performed with the engine operating on one, two and four cylinders, respectively. Spark plugs and push rods were removed from the non-operating cylinders for the one and two cylinder tests. Valve clearance and spark timing were set at manufacturers' recommendations on the firing cylinders.

The carburetor was lowered one-half inch and turned 26 deg to accommodate straight intake pipes (See Fig. 1). The governor-throttle plate linkage was disconnected and the throttle manually locked in the wide-open position. The engine was loaded with a cradled, eddy-current dynamometer.

Paper presented at the Winter Meeting of the American Society of Agricultural Engineers at Memphis, Tenn., December 1960, on a program arranged by the Power and Machinery Division.

The authors — J. C. McMunn, R. R. Yoerger and J. A. Weber — are, respectively, associate engineer, structural dynamics group, McDonnell Aircraft Corp., St. Louis, Mo., and professor and associate professor of agricultural engineering, respectively, University of Illinois, Urbana.

Acknowledgment: The authors acknowledge the contributions of Joseph Clegg, who investigated certain phases of the study as a part of his undergraduate program, and of the Illinois Farm Supply for their support of the tractor maintenance project under which the work reported in this paper was completed.

*Numbers in parentheses refer to the appended references.

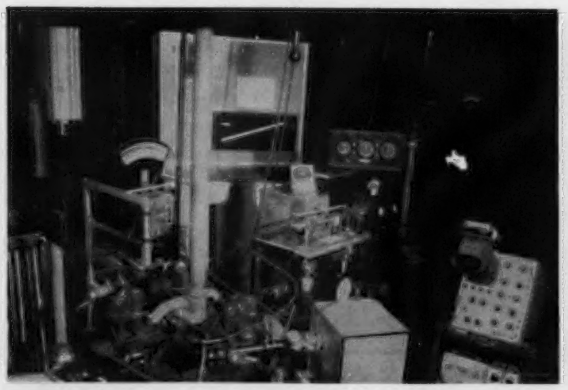


Fig. 1 Test engine showing intake pipe and pressure transducers

Fig. 2 Experimental test setup showing engine and instrumentation

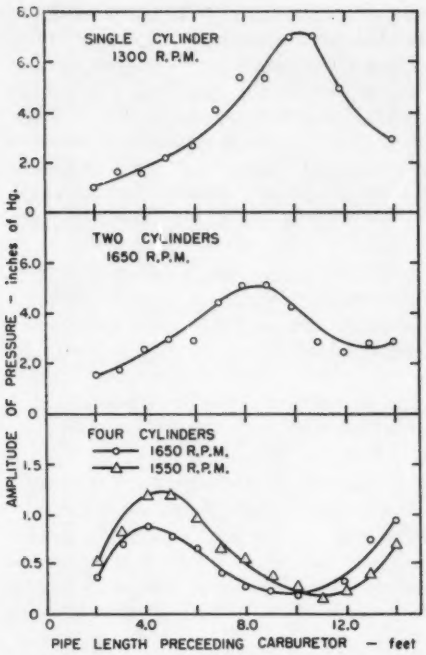


Fig. 3 *(Left)* Amplitude of pressure (carburetor entrance) vs. pipe length

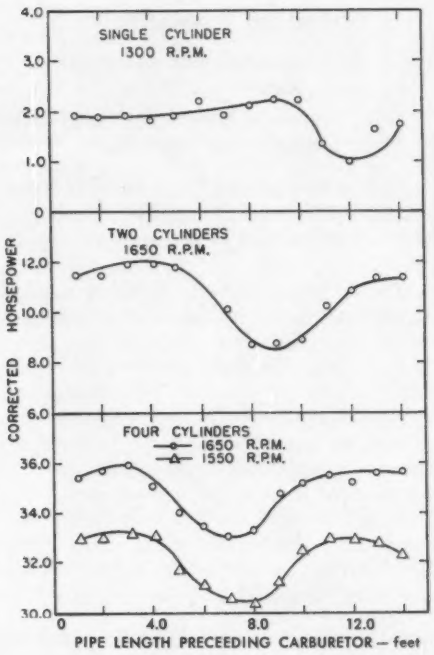


Fig. 4 *(Right)* Engine power vs. pipe length (wide-open throttle)

The intake pipe was varied in length from one foot to fourteen feet in one-foot intervals. The pipe was positioned to eliminate the effect of bends on the air column prior to the carburetor.

Pressures were measured at two locations in the intake pipe, one near the carburetor entrance and the other near the outer end of the pipe. Pressure transducers employing electrical-resistance strain gages were used for pressure measurement. The output of the transducers was channeled into an electronic system and continuously monitored on a dual channel oscilloscope (See Fig. 2). A 35 mm camera was used to record the pressure traces.

All changes in pipe length were made between the two transducer locations. Thus one transducer was a fixed distance from the intake ports, the other at a variable distance so that the magnitude of damping due to the intake pipe could be determined.

All tests were run at constant engine speed. Four speeds were selected: normal rated engine speed (1650 rpm), one speed above rated speed (1750 rpm), and two speeds below rated speed (1450 and 1550 rpm). All selected speeds except that of 1750 rpm are in the wide-open throttle overload range of this engine.

Measurements were made of induction system air temperatures, mass rate of air flow into the engine, fuel consumption and engine output torque. The induction system air-temperature gradient was determined and a mean temperature was used to calculate the sonic velocity in the pipe. An air cleaner was not installed during the pressure measurement phase of testing and the air entering the pipe was held at atmospheric pressure.

Amplitude of Pressures

The maximum pressure amplitude measured was 7.0 in. of mercury (3.44 psi gage) at the carburetor entrance with 11 ft of pipe on single-cylinder operation. This is in the pressure range reported by other research workers. The pressures decreased rapidly with pipe lengths greater or less than 11 ft. (See Figs. 3 and 5).

The pressure amplitudes decreased as the number of cylinders were increased for all pipe lengths and engine speeds. The pressure amplitudes did not change much with speed change at a given pipe length for four-cylinder operations. It is felt that a wider speed range would have shown a difference in pressure amplitudes under these operating conditions.

When operating the engine on a single cylinder, a damped vibration exists in the induction system since the intake valve is closed for approximately three fourths of the time. During this period there is no exciting force on the air column and the amplitude is continuously reduced. A similar situation, however, does not exist on four-cylinder operation because an intake valve is at least partially open at all times to permit air to flow inward. Thus a vibration with an amplitude similar to that which occurs in single-cylinder engine induction systems cannot exist with a single manifold and intake pipe that serves all four cylinders.

Frequency of Pressure Pulsation

For the engine operating on a single cylinder air is permitted to flow into the cylinder only during the portion of the cycle when the intake valve is open. During the valve closure period, the air column in the induction system vibrates at its natural frequency which is dependent upon the velocity of sound in the gas and the pipe length and is expressed by

$$f=\frac{\sqrt{gKRT_m}}{4Lc}$$

where f=natural frequency cycles per second
g=gravitational constant, feet per second squared
K=ratio of specific heats, dimensionless

. . . Pulsating Pressures

R=gas constant, foot lb. force per lb. mass-degree Rankine

T_m=mean gas temperature, degrees Rankine

Lc=effective pipe length, feet

This is the equation for the natural frequency of a gas column in a closed-end tube. The flow can be reversed and air will flow outward from the intake manifold for a short period.

The primary pulsations for two cylinder operation have the same frequency as that of the opening of the intake valves.

Some high-frequency pressure fluctuations were also visible on the oscilloscope. These fluctuations were modulated on the fundamental pressure signal (See Fig. 5).

It is not known what caused the high-frequency vibration, but the magnitude of the signal is quite small compared to that of the fundamental pressure signal.

Several pressure traces indicated rapid rates of pressure change in the induction system. The maximum rate observed was 445 psi per second. In general, the rate of pressure change decreased as the number of cylinders increased.

Pipe Length Effect on Engine Power

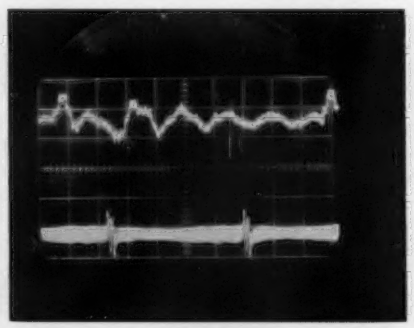
The length of intake pipe preceding the carburetor was varied in one-foot increments to determine the pipe-length effect on engine output power. The speed was held constant and the throttle plate was locked in a wide open position. The load on the engine and the air consumption were measured for all tests.

It was found that the length of intake pipe beyond the carburetor does have an effect on engine power. Over the range of pipe lengths investigated (1 to 14 ft) two different lengths were found to provide maximum engine power output and one to provide minimum power output for each engine speed at wide-open throttle operation. Fig. 4 shows the output power as a function of pipe length for the different operating conditions. The power output peak associated with the longer pipe length was in most instances slightly lower than that at the shorter pipe length. The curves indicate gradual changes without any discontinuities or sharp inflection points.

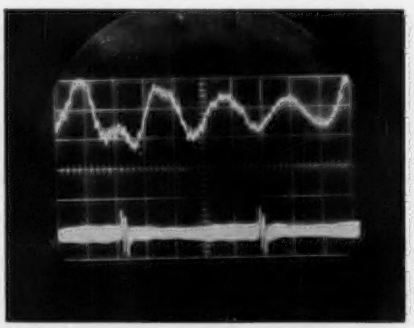
There are some pipe lengths which reduce the power output from that obtained with no pipe beyond the carburetor. This means that an intake pipe can produce beneficial or detrimental effects on the engine power depending on the pipe length. Also, if an engine is tuned with a pipe length at one speed to increase power, and is then operated somewhat above or below this speed a reduction in power may occur.

The method of boosting power by changing the length of intake pipe is commonly called "inertia supercharging" or "tuned-intake system" and has been explored by investigators in Italy, Germany and China, as well as in the United States. The work has been conducted mainly on single-cylinder engines because of the simplicity of supporting analytical analysis.

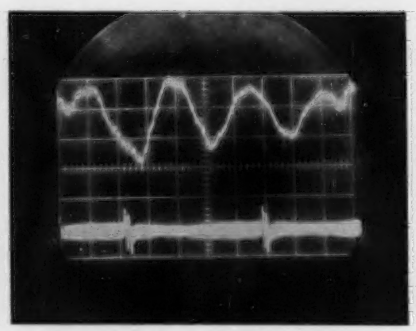
Morse et al (3) reported as many as five different pipe lengths which would increase engine power over that obtained with no intake pipe on a single cylinder engine. The shortest length was tuned to the fundamental natural frequency of the system and the longer lengths were tuned to higher harmonics. The power gain was a maximum for the fundamental frequency length and became progressively smaller as the tuned lengths increased. Investigations have



Two feet of pipe

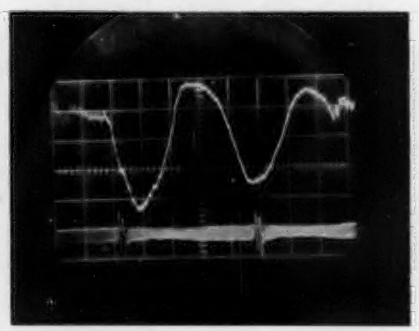


Four feet of pipe



Five feet of pipe

Fig. 5 Oscilloscope traces from single-cylinder operation at 1300 rpm, wide open throttle. (Upper trace) Intake air pressure near carburetor. (Lower trace) Bottom dead center (20 milliseconds per centimeter division)



Nine feet of pipe

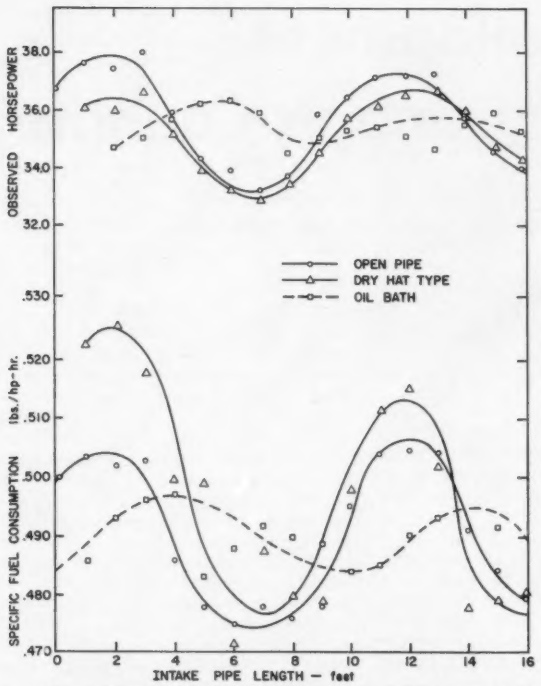


Fig. 6 Engine horsepower and specific fuel consumption vs. intake pipe length (4 cylinders, 1650 rpm)

also been carried out on the use of air surge chambers in the induction system to act as an air capacitor and on the effect of branched and unbranched pipes on the induction system.

The Air Cleaner

The pulsating pressures in the engine intake system undoubtedly account for some of the unexpected trouble encountered in adapting dry-type air cleaners to tractor and other engines that normally operate near wide open throttle a large portion of the time. The cleaner elements on identical engines may be subjected to widely varying conditions depending upon the length of pipe between the cleaner and the engine.

The upper portion of Fig. 6 shows the effect on power output of adding two different types of air cleaners to the outer end of the engine intake pipe. The addition of a dry-type cleaner consisting of a cylindrical paper element approximately 9½ in. in diameter and 3⅝ in. in height and a metal "hat type" cover did not change the shape of the power curve appreciably from that of the open pipe. The major influence was that of reducing the power output which can be partially accounted for in the increased restriction of the filter element.

The power curve obtained with the original equipment oil bath cleaner for this engine is different in shape and has considerably less variation than that of either the open pipe or hat-type cleaner. In attempting to align the maximum and minimum values of the oil bath with the open pipe, it is necessary to shift the curve the equivalent of approximately six feet of intake pipe. The air travels approximately four feet in passing through the oil bath unit; however, it appears to have an equivalent open pipe length of about six feet.

Specific Fuel Consumption

The lower portion of Fig. 6 shows that the specific fuel consumption (pounds of fuel per horsepower-hour) varies in the same manner as horsepower and probably has a direct relation to the power curve. For the open pipe the maximum variation in specific fuel consumption was about 6 percent and the maximum variation in power output was about 13.5 percent. With the hat-type cleaner the engine performed in much the same manner as with the open pipe while the variations in specific fuel consumption as well as horsepower were much less with the oil bath.

The air-fuel ratios for the open pipe tests were found to be richest for the tests with lengths of intake pipe producing maximum power, the total variation from the richest to the leanest observation being approximately 12.5 percent. These results also indicate the importance of considering the dynamics of the air intake system in the design of carburetion for the tractor engine.

Summary

A considerable amount of research has been conducted on the effect of intake pipe length on engine power. Much of the work has been with single-cylinder engines to take advantage of the "tuned" or "inertia supercharging" effect. Only a limited amount of work on multicylinder engines is found in the literature and four cylinder operation of a farm tractor engine indicate sizeable variations in intake air pressure pulsations with different lengths of intake pipe extending outward from the carburetor. The dynamic characteristics of the intake air column can have marked effect on engine power output, air-cleaner performance and carburetor performance. Special consideration should be given to the design of the intake systems on tractor and other engines that are expected to operate a large percentage of the time at or near wide open throttle.

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Research Summary on Water Supplies

A "SUMMARY of Research on Individual Household and Farmstead Water Supplies" is available from ASAE, 420 Main St., St. Joseph, Mich., at 50 cents per copy or in exchange for one Technical Paper Order Form.

This report, prepared by the ASAE Water Treatment and Use Committee, is a summary of the results of a questionnaire sent to agricultural engineering and sanitary engineering departments, as well as persons dealing with research in the area of individual household and farmstead water supplies. Replies were received from 42 states and 3 Canadian provinces.

Water Resource Development in Mediterranean Countries

Author's report on work as consultant in water resource development in Greece, Turkey, Syria, Iraq, and brief trip to Spain

J. E. Christiansen
Member ASAE

DURING the past two years the Food and Agriculture Organization of the United Nations has been engaged in an economic development study of most of the countries bordering the Mediterranean Sea. The project was initiated by the forestry division of FAO, but was expanded to include the agriculture and economic divisions. The study included a visit to each of the countries involved by a team representing each of the divisions. The team was sometimes accompanied by a consultant in a field of special interest to the country concerned.

Presented as Paper No. 59-715 at the Winter Meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 1959, on a program arranged by the Soil and Water Division.

The author — J. E. CHRISTIANSEN — is professor of civil and irrigation engineering, Utah State University, Logan.

Economic Problems and Agriculture

Although there were some differences in conditions and problems encountered in several countries, there were also many similarities. These included a general underdevelopment of the economic potentials with a high proportion of the population dependent upon agriculture for a livelihood. In general, agriculture is much more primitive than in the United States, although in some places new areas have been brought under cultivation since World War II, and are being farmed with modern equipment in much the same way as our dry land is farmed in the western states. Primitive methods and equipment are generally used, however, and the area worked per family is small. Attempts at mechanization have not been entirely successful, primarily because of the small holdings and the lack of opportunity for transfer of surplus farm labor to industrial employment. As a matter of basic economics, it seems that little is gained by the introduction of mechanization and labor-saving equipment unless the labor saved can be effectively utilized. This is a major problem that confronts all of these countries. Without modern equipment, agricultural output per capita is very low, and the farmer enjoys little more than a subsistence living. The term "farmer" refers to the man who actually tills the soil, and not the landowner who frequently owns large holdings that are farmed by sharecroppers. In all of these countries the governments are greatly concerned with the plight of agriculture and are desperately striving to better the condition of the farmer by various means.

From a long-term point of view, something must be done to increase the production of food to keep pace with the rapid increase in population. In most of the countries it is difficult to see how production can possibly be increased sufficiently to take care of the expected population in the next 25 years. Although there is an overproduction of food, cotton and tobacco in some countries, there is a shortage or impending shortage in others, and the balance of trade is generally such that importations are very limited. Many countries depend upon the exportation of foods, or other agricultural products, to offset the importation of essential manufactured products. Greater industrialization in all of the Mediterranean countries is essential to achieve a higher standard of living.

To meet the need for increased production of foods, fiber, and wood products, the governments are looking toward fuller development of their water resources. Irrigation is old in all of these countries, but until recently only water supplies that could be developed by primitive means, or at low cost, have been utilized. Since World War II there has been increased activity in the development of multipurpose projects, including storage of water for irrigation, hydroelectric power and flood control, and the drainage and reclamation of waterlogged and marshy lands. The U.S. International Cooperation Administration and the Food and Agricultural Organization of the United Nations have aided in these developments.

GREECE

(Left) **Debris and flood control are major problems in water resource development in northern Greece**

(Right) **Control structure on flood control and drainage project in northeastern Greece**

(Left) **Headgate structures at division point on large canal in northern Greece**

Organization

The organization of the water-development programs in most of these countries is similar. In general, the major projects are developed by the Ministry of Public Works or an equivalent agency. In Iraq, it is the Development Board in the Ministry of Development, which is responsible for both water resource and industrial development. The development board has received 70 percent of the oil revenues accruing to the government. These funds have been used for the construction of storage dams, flood control works, irrigation distribution systems, and drainage works. The construction program has materially slowed down since the revolution in July 1958. The government irrigation projects are operated by the irrigation department in the Ministry of Agriculture.

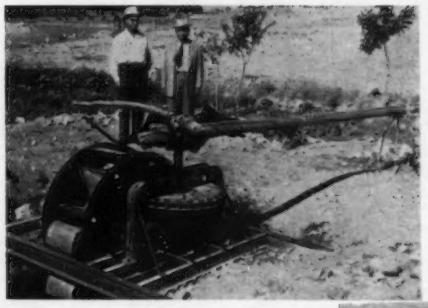
In Turkey, the state hydraulic works, known as the DSI, builds and operates the major projects. The development of small projects, and the promotion of irrigation within the large projects, including land preparation, research in irrigation and drainage, and soil conservation, is the function of the soil conservation and farm irrigation division in the Ministry of Agriculture. This organization is patterned after our Soil Conservation Service, and is staffed largely by an enthusiastic group of young engineers and agronomists who have had either a formal education or practical training in the USA, generally under the direction of the ICA. Utah State University has played an important part in this training, as about 25 staff members have attended Utah State either as regular or special students.

Greece is divided into two major regions. The states of Macedonia and Thrace in Northern Greece are administered by organizations in Salonica and the remainder from Athens. There are several organizations concerned, but major projects are constructed by the Ministry of Public Works, with the final distribution systems and operation under the Ministry of Agriculture. A Ministry of Coordination allocates funds for the development programs. The extension service also has a "Small Land Reclamation Works" program to develop and improve small irrigation and drainage projects for which the government pays part of the cost.

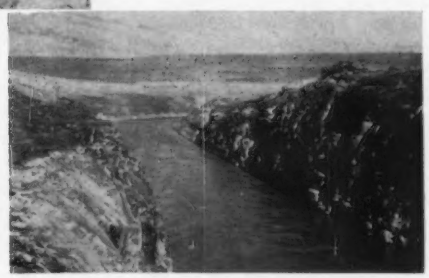
In Syria, the irrigation department in the Ministry of Public Works constructs and operates most of the government project. The major project under construction at present, the Ghab Project, is under a separate administration.

In Spain, the Ministry of Public Works builds the dams and major canals. The Institute of Colonization completes the projects, constructs the minor channels, prepares the land for irrigation, and subdivides it into small farms of 12 to 20 acres. This organization builds the villages, secures the settlers, and carefully supervises their activities during a five-year trial period. The service rendered by the Institute appears much more complete than that furnished in any of the other countries.

SYRIA U.A.R.



(Left) Animal-powered water lifting devices are being replaced by small gasoline powered pumps



(Right) Outlet channel for large drain cut through basalt formation at lower end of the Gab Valley

IRAQ

(Left) Headgate on diversion canal in Diyali River

(Right) Diversion weir on Diyali River

Storage Projects

Further development of water resources in these countries usually necessitates storage. The Mediterranean climate, with warm, dry summers and much of the winter precipitation in the form of rain, produces heavy runoff during the winter and early spring. To utilize the water supplies to a greater degree than they have been used over past centuries requires storage. Most projects are planned for multipurpose benefits, including flood protection to permit better use of the land resources, and the production of electric power where this is feasible. Many projects are now under construction or have been recently completed. In some countries, foreign aid from the United States, or the International Bank, has helped finance such projects. In many instances these projects have been investigated, planned and designed by American engineering firms, and have been built by international construction firms representing many countries.

In Turkey, the DSI has completed or has under construction, a total of 13 dams representing earthfill, rockfill, and concrete gravity types, and having reservoir capacities of 2430 to 4,860,000 acre-feet. All of these dams provide flood control and irrigation benefits, and four produce hydroelectric power. In addition, Beysehir Lake, with a controlled outlet, has a storage capacity of about 130,000 acre-feet. Two other major dams have been built for power production.

. . . Water Resource Development

Syria has one major reservoir, the Lake of Homs, on the Orontes River, with a capacity of about 160,000 acre-feet. Another dam under construction downstream on the same river will provide storage of 210,000 acre-feet. Further downstream, a regulating reservoir will provide additional storage of 33,000 acre-feet. These two reservoirs will provide for the irrigation of about 150,000 acres in the Ghab, a large swampy valley now being drained. Another major project is under investigation on the Euphrates River, with the aid of Soviet engineers, to irrigate several hundred thousand acres. This will involve a major dam on the Euphrates River.

Iraq has just completed the Dokan Dam, a concrete arch structure 382 feet high on the Lesser Zab River, a tributary of the Tigris. This dam will store 4.9 million acre-feet. Another rockfill dam, the Derbendi Khan, is presently under construction on the Diyala River, another tributary of the Tigris. This dam, 443 feet high, will store 2.4 million acre-feet. Habbaniyah Lake provides 2.6 million acre-feet of offstream storage for the Euphrates River. Additional storage is planned to provide for irrigation and flood control. The major storage for the Tigris will be offstream in the Tharthar Depression. The inlet works are complete and the basin is presently used for flood control. To utilize it for irrigation storage will require a large expenditure for outlet works. This reservoir may provide as much as 24 million acre-feet of storage. Other dams are planned to provide complete control of the river, and for irrigation in northern Iraq.

Spain has completed, or has under construction, several major storage reservoirs for the irrigation of new land in widely separated areas. The Badajoz Project in western Spain will have, when completed, four major dams with combined storage capacity of more than 3 million acre-feet, to irrigate 300,000 acres and produce 250 million kilowatt-hours of electric energy per year.

Greece has constructed some storage reservoirs, but will depend chiefly upon natural flow for the irrigation of large areas, especially in northern Greece. Here the major problem has been the control of the larger streams as they discharge onto the coastal plain. Construction work has included major flood protection levees, drainage channels, diversion dams, and canal systems. A diversion dam on the Axios River has recently been completed at a cost of about 2.5 million dollars. The major streams in northern Greece originate in Yugoslavia and Bulgaria. Storage sites in Greece are limited. Because of the torrential nature of the streams, flood and debris control are major problems.

Groundwater

Groundwater has been of considerable interest in all of the countries, but particularly in Greece, where it is estimated that 37,000 acres are irrigated from wells. This represents about 8 percent of the total irrigated area. About 1600 successful wells have been drilled by the government since 1948. No large areas comparable to those in California, Arizona or Texas are irrigated from groundwater in any of these countries.

Extensive groundwater investigations have been carried on with aid from ICA and FAO, but many difficulties have been encountered in developing economical supplies for irrigation. In Syria and Iraq especially, groundwater is probably of greater interest and value for village and stock water supplies, than it is for irrigation, although there are a large number of irrigation wells. In comparison with developments in the United States, the wells are much smaller and are often open, dug wells equipped with either primitive devices or small centrifugal pumps. Turkey has recently completed the construction of 50 deep wells for the irrigation of a tract near Konya, but had not installed the pumps. Restrictions on imports, in order to maintain a balance of trade, is one of the difficulties involved in development of groundwater.

SPAIN

(Left) **Control works on large diversion dam in northen Spain**

(Right) **Large reinforced concrete flume on irrigation canal near Zaragosa**

TURKEY

(Right) **Earth fill dam under construction on the Kum River, a tributary of the Gediz River near Izmir. An unusual filter design was used**

Irrigation Methods

The most common type of irrigation observed was by means of small basins, often constructed with hand-built levees. Furrow irrigation of row crops is also extensively practiced. Inadequate land leveling and preparation for irrigation is prevalent. Small fields and a shortage of heavy tractors and land-leveling equipment makes the problem difficult. Spain probably has made the most progress along this line, and in new projects the land is being carefully leveled and bench terraces are constructed on sloping land. This work is done by the Institute of Colonization with modern equipment before the projects are turned over to the settlers. On one project visited in southern Spain, eight large crawler tractors, with large scrapers or land planes, were in operation. Turkey has also recognized this problem, and the Soil Conservation and Farm Irrigation Division has secured a considerable amount of equipment for use in some areas. This division provides farm planning and engineering services without charge, but makes a charge for construction work. It has also developed small implements that can be drawn by horses or mules for preparation of land for irrigation. Much remains to be done, however, in all of these countries before the water can be efficiently applied.

Sprinkler irrigation is practiced in some places, including northern Greece. Near Salonica, a number of sprinkler systems were in operation. Some were pumping water from canals or drains, and others from small tube wells. Most were comparatively small systems with only one or a few rather large-capacity sprinklers. Much of the sprinkling is done by contractors who own the equipment and charge for the area irrigated.

Drainage

Land drainage and reclamation of saline soils are problems in most irrigated areas, except where the topography and geology are such that natural drainage suffices. As was generally the case in the earlier days of irrigation in the United States, the importance of drainage was not recognized until the salinity and alkali conditions became acute. Today in most of the newer irrigation projects, the need for drainage is recognized and provision for drainage is incorporated in the project planning. Turkey is acutely aware of the need for land drainage and salinity control, and has benefited from assistance rendered by ICA. Little has been done to determine the feasibility of ground water control by pumping from wells. It is believed that this method of drainage might prove successful in some of the coastal areas of Greece and Turkey. Further investigations and experimentation would be necessary to evaluate such possibilities.

The situation in Iraq is quite different from that in other countries. Irrigation has been practiced without drainage in the Mesopotamia Valley for about 5,000 years, and the people have learned how to "live with salt." Drainage and salinity reclamation are certainly the major problems on hundreds of thousands of hectares. Only the higher land near the banks of the major rivers, the Tigris and Euphrates, which enjoys a degree of natural drainage, is reasonably free of salt. Major drainage projects, to provide the main outlet drains for large areas, are now under construction. Without such outlets, the farmers have been helpless to do anything about drainage, and an interesting agricultural practice has developed. Most of the land in the salty areas is planted to barley or wheat. The land is usually preirrigated in the late fall and then plowed and planted. One or two additional irrigations are applied, and after harvest the land lies idle for 18 months or more, allowing the salt-resistant weeds to grow. The land is grazed during this period, but through natural selection, the plants that have survived have little forage value except for camels and goats. The weeds, some of which are legume, add some nitrogen to the soil, and they also lower the water table during this fallow period so that on alternate years a crop can be grown. With a dry subsoil and low water table, the preirrigation moves surface accumulations of salt downward sufficiently so that grains will germinate.

As would be expected, yields are very low. Only a small percentage of the area is devoted to summer crops, except where dates and rice are grown. Concentrations of salt in the subsoil, principally calcium chloride, are very high. Some experimental work conducted recently indicates that with drainage the soils can be reclaimed. Some calculations indicated that, at the experimental site, the amount of salt in the permeable soil above and dense clay layer, at about 3.5 meters depth, was about 1500 tons per hectare.

The Mesopotamia Valley is similar in many respects to the Imperial Valley in southern California, except that it is about ten times as large. The soils, climate, and salt composition of the irrigation water are similar, except that for most of the year the salt content of the Euphrates and Tigris Rivers is less than half that of the Colorado River. The soils have been built up by centuries of accumulations of silt from the rivers. Maintenance of canal systems is a very difficult problem because of silt. In many places the remains of large ancient canal systems, that have been long abandoned, are in evidence by the mountains of silt that have been removed from the channels and piled along the canal banks.

Summary and Conclusions

Water-resource development is a very important part of the economic development program in all of the Mediterranean countries. Some economists believe that it will be only through an increase in irrigated area, with higher average yields, that these countries can substantially increase their food production to meet future needs.

The water development programs in most of the Mediterranean countries are carried on by organizations similar to the U.S. Bureau of Reclamation, usually in the ministry of public works. In some countries, such as Turkey, an additional organization, similar to the U.S. Soil Conservation Service, also has a vital part in this development. In Spain, the Institute of Colonization plays an important role.

Storage of water, generally for multipurpose benefits, including flood control, power development, and irrigation, is a major part of the development program. As is generally true in our western states, the natural stream flow and other easily developed supplies are now fully utilized. Future increases in irrigated area will depend largely on the construction of reservoirs to store winter and flood runoff.

Groundwater development is of considerable importance in several areas, but has not yet achieved the status that it has in several of our western states. In some places it appears that groundwater could not only become important as a source of supplemental supply, but its development might be an important factor in the solution of the drainage problem.

Land drainage and reclamation are very important aspects of the development program in several places. Without doubt, drainage and salinity reclamation is the major problem in Iraq. Before the agricultural potentials of most of these countries can be achieved, however, the floods must be brought under control, and in some places large marshy areas must be drained.

Looking Forward

If peace prevails, and financing can be arranged to complete the projects now being planned or under construction, a significant increase in area irrigated will be achieved in the next ten years. There is some question, however, as to whether the increase in production, from the irrigation of new areas, or by improvement of lands presently under irrigation, can keep pace with the needs of the expanding population.

ALUMINUM EXTRUSION DESIGN AWARDS

The Aluminum Association has announced the establishment of two awards for design in aluminum extrusions. The competition, sponsored by the Aluminum Extruded Products Division, was created to draw attention of the manufacturing public to the special versatility offered by the extrusion process. Two categories of participation have been defined by the Awards Committee. The first, for the most ingenious extrusion, will evaluate entries in terms of originality, difficulties involved, and total accomplishment. The second category, for the most noteworthy extrusion converted into a finished part, will involve the additional criteria of market potential and esthetic value.

Any extrusions firm in the United States may make nominations from among its own or its customers' personnel and is eligible itself for a companion trophy if its nominee wins. Entry deadline for the awards is September 29, 1961. Details and entry forms may be obtained from Awards Committee, The Aluminum Association, 420 Lexington Ave., New York 17, N. Y.

INSTRUMENT NEWS

Floating Lysimeter

Uses heavy liquid for bouyancy

W. D. McMillan and H. A. Paul
Assoc. Member ASAE

THE short-term measurements of evapotranspiration needed to evaluate crop response to varied soil moisture and meteorological conditions has led to the development of many types of weighing lysimeters during the past few years. Flotation, and the application of Archimedes' principle, has proven to be a relatively inexpensive and reliable means of weighing a large soil mass.

The operation of a floating lysimeter that uses water for buoyancy was described by King, Tanner and Suomi (1)*. Experience with a pair of lysimeters of similar design during the past two years has indicated that the major drawback to these lysimeters is the large air chamber required to provide buoyancy for the soil mass. The air chambers restrict the depth of rooting, thus limiting the usefulness of these lysimeters. A previous discussion (2) compared the performance of these tanks with a 20-ft diameter weighing lysimeter described by Pruitt and Angus (3). The relative economy and reliability of these floating lysimeters has led to a modification in design that extends the usefulness of this type of installation.

Fig. 1 indicates the design of recently installed lysimeters that utilize aqueous zinc chloride, with a specific gravity of approximately 1.90, for flotation. This heavy liquid eliminates the need for large air chambers and the structural features of the floating tanks are greatly simplified. Zinc chloride, in granular form, was mixed with water at the lysimeter sites to provide a liquid of the desired volume weight. The chemical is relatively inexpensive, dissolves easily, and the corrosive action of the liquid is withstood by most asphaltic coatings.

The lysimeter tank and stilling well walls indicated in Fig. 1 are 12-gage steel, hot dip asphalt coated, and are reinforced with 1¼ x 1¼ x 3/16-in. angle hoops. Three small chambers (two shown in Fig. 1) with attached riser pipes are provided in the inner tank for drainage and weight adjustment. Drainage water is removed from the chambers by pumping, and ballast, in the form of steel-punch burrs, is added or subtracted to adjust the weight and increase the stability of the floating tank. Tension drainage systems are also being installed in lysimeters now under construction.

An oil film on the liquid at the lysimeter and stilling well minimizes the gain or loss of water vapor from the zinc chloride solution. A pressure-sensitive plastic tape used to seal the gap between the inner and outer tank rims prevents liquid from moving in or out of the flotation system without restricting vertical movement of the floating tank. Two short lengths of chain fastened between the tanks prevent the inner tank from rotating or rubbing against the outer tank. The relatively viscous zinc chloride solution acts to reduce surge in the liquid system arising from wind forces on the surface of the floating tank.

A float-actuated, liquid-level recorder at the stilling well provides a continuous record of weight changes of the floating tank. Since the zinc chloride solution is nearly twice as heavy as water, the effective magnification of the water-stage recorder is reduced by one-half, in terms of equivalent depths of water over the lysimeter surface. Water-stage recorders with 5:1 and 20:1 mechanical amplification, suitable for daily and hourly measurements, have been obtained by modifying the mechanical linkage of commercially available recorders.

The recorder house indicated in Fig. 1 protects the recorder and serves an important function in minimizing the temperature changes at the stilling well. A small glass-tube side stilling well (not shown in Fig. 1) is used to obtain reference measurements of liquid levels to the nearest 0.001 in. with a micrometer point gage.

Field calibration of the recorder is carried out during periods of low evaporation by adding and subtracting weight on the surface of the floating tank and noting the corresponding changes on the recorder chart. The ratio between evaporation loss, expressed as an equivalent depth

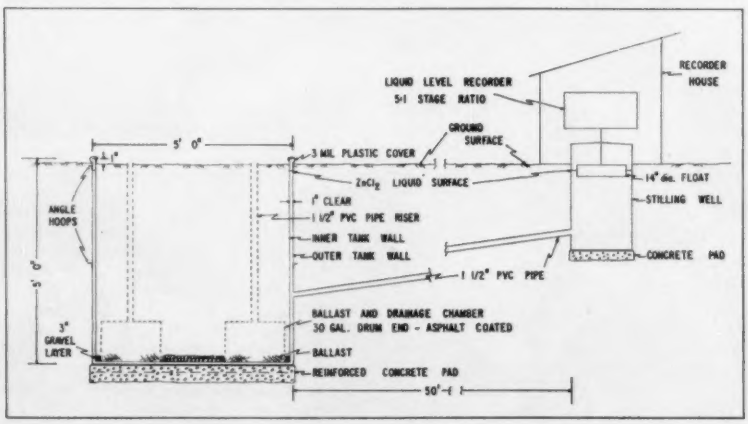


Fig. 1 Diagram of a floating lysimeter installation

An Instrument News Contribution. Articles on agricultural applications of instruments and controls and related problems are invited by the ASAE Committee on Instrumentation and Controls, and should be submitted direct to Karl H. Norris, instrument news editor, 105A South Wing, Administration Bldg., Plant Industry Station, Beltsville, Md.

The authors — W. D. McMillan and H. A. Paul — are, respectively, assistant research engineer and junior engineer, department of irrigation, University of California, Davis.

*Numbers in parentheses refer to the appended references.

(D) of water over the lysimeter surface, and the change at the recorder *(R)* is a function of the recorder magnification *(M)*, the specific gravity of the liquid (S_L), and the relative cross-sectional areas of the floating tank (A_S) and the liquid surface at the lysimeter and stilling well (A_L). By application of Archemedes' principle this relationship can be expressed as

$$R/D = M\ A_S/(A_S + A_L)\ S_L$$

For the lysimeter shown in Fig. 1 the R/D ratio is 0.48 M. The 5:1 liquid level recorder ($M=5$) permits readings equivalent to 0.008 in. of water on the lysimeter surface. The recorder is maintained on a weekly basis and provides a relatively inexpensive and reliable record of evapotranspiration and rainfall.

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3 Pruitt, W. O. and Angus, D. E. Large weighing lysimeter for measuring evapotranspiration, TRANSACTIONS OF THE ASAE, 3:(2)13-15, 18, 1960.

. . . Spreading Dry Materials by Airplane

(Continued from page 487)

Conclusions

From the wind-tunnel studies and the following flight studies of ram-air type distributors, it is indicated that a comparatively large cross-sectional area is necessary. It is also indicated that moderate or no constriction in the throat is the most efficient.

In order to obtain a wide swath with a heavy, granular material, such as granular fertilizer or wheat, it appears desirable to have a distributor with a short straight section (deflecting vanes starting immediately behind the chute); moderate radius deflecting vanes (7 to 11 in. as measured in Fig. 7); extensions of sufficient length so the material being applied is in the outside vanes of the distributor for approximately two feet; and an outlet angle of 50 deg or more.

For light materials, such as granular insecticides, a longer, straight section (deflecting vanes starting some distance behind the chute) would produce a wider swath, although having longer extensions (more over-all width at the outlet) would probably be more important. For these materials, the extensions should be long enough so the material would be in the distributor for at least two feet. In addition to having a wide distributor, so these materials will be moving through it for some distance, it is no doubt important to have it wide enough so the materials will be thrown out beyond the propwash. For a light airplane then, it would be desirable to have the distributor six feet wide or more at the outlet for obtaining a wide swath with these light materials.

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4 Kohlman, E. H. Basis of design for an adjustable venturi. Special problem report 136, agricultural engineering 702-703, Ohio State University, March 1954.

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. . . Grain Drying

(Continued from page 489)

comes evident in the design procedure, each successive increment of increased air volume becomes more costly. On the other hand, all increments of increased temperature cost about the same. For this reason a desired capacity can sometimes be achieved more economically by raising the air temperature than by increasing the air volume. In a sense this amounts to substituting a fuel cost for part of the power cost. This results in a reduction of total cost in many cases. Thus one of the reasons for using supplemental heat is to extend the practical limit of drying capacity in in-storage drying systems.

The other reason for using supplemental heat is that, in an unheated-air drying system, it is impractical to design against the most unfavorable weather that can ever occur. Any drying system will eventually be used in a season when the humidity stays high for exceptionally long periods. In this case, supplemental heat can be added and the drying accomplished successfully in spite of the weather.

There is no single method of control of supplemental heat drying that is superior to all others. Various methods are used, and it may be expected that eventually standard methods will be adopted. Since the final grain moisture content depends on the relative humidity of the air, a humidistat may be used. The humidistat can be located outside the building and control the burner by sensing the atmospheric relative humidity. It can be located in the stream of heated air on the way to the grain. In either case, one of the problems is likely to be maintaining a uniform response to humidity changes. Most humidistats need protection against accumulations of dust or dirt as well as against mechanical damage.

Perhaps the simplest method of control is to adjust the burner for a continuous constant temperature rise with manual adjustment of the fuel rate as the situation requires.

If the operation is one for merely taking care of periods of high humidity so that drying will be continuous regardless of weather, a humidistat control is probably best. In this case a setting to assure that the average relative humidity does not exceed 65 to 70 percent would be adequate. A maximum temperature rise in the air of not over 10 degrees would suffice.

Supplemental heating appears to have its best application in providing maximum drying capacity in which case it is not merely supplemental to unheated-air drying. In combination with layer drying and deliberate temporary overdrying, it results in an economical drying system that can fit in nicely with many farming operations. It perhaps takes more judgment on the part of the operator to take full advantage of it than do other drying systems. Coordination with the rate of harvesting and bin filling and some attention to the extent of overdrying are important in getting the most out of the system.

. . . Partners — Engineers and Industry

(Continued from page 477)

because I think the family-operated farm will long continue dominant in our agriculture.

An additional barnyard calculation or two should convince even a western Missouri cattleman that the total amount of labor needed to produce our spectacular increases in farm output has fallen abruptly. In 1960 alone farm output per man-hour jumped 8 percent versus 2 percent for the rest of our economy. Just 20 years ago it required better than 20 billion man-hours to produce all our crops and livestock. Last year half that amount of labor was used to deliver 50 percent more production.

That is the sort of change for which agricultural engineers have largely been responsible. In another ten years we will have over 200 million people in our country. We will be better fed and clothed than ever before by the output of a mere 800,000 full-time, highly specialized, family-operated farms. They will account for 90 to 95 percent of the total agricultural output. Two hundred thousand of them will be dairy farms. There will be around 25,000 range outfits furnishing feeder stock to some 150,000 finishers. Another 150,000 farms will take care of hog production; 80,000 operators will be handling the poultry business, and the remaining 200,000 commercial producers will produce all the cotton, wheat, tobacco, peanuts, rice, sugar crops seed, vegetables, fruit and nuts we can consume and give away to our more indigent human relatives. That is where our partnership will be in 1970.

We will also have 800,000 or fewer real farms. Already less than 800,000 are accounting for about three-quarters of the total output. Our agriculture will be giving direct employment to less than 4 percent of our population. One farm worker will be supporting forty-five other people, as compared with twenty-five now.

Last year our farm population of around 16 million produced farm goods roughly equal to the total output of Red China's 500 million peasants. Our 16 million farm people produced 60 percent more than Russia's 110 million.

By 1970 our farm output per man-hour will have nearly doubled again, as it did in the past ten years. Production assets per real farm will average around $65,000, nearly double the present figure and ten times that of 30 years ago. By 1975 capital investments of $200,000 per farm will be commonplace.

We will continue to have more to eat than is good for us, but don't expect that to dampen the world's population explosion. More people still die young from undernourishment than from the reverse.

As farms get fewer, larger and more specialized, the substitution of capital for human energy accelerates, and along with it the importance of management skill in handling the five big M's of production — men, money, materials, machines and minutes. Suppliers of specialized knowledge, services and equipment are sought after. A recent Doane survey showed that a lot of farmers are making more than twenty trips a year outside their own counties to get technical information. Suppliers who have it for them will do better than those who don't. The services of agricultural engineers will be in increasing demand.

A rapidly changing technology offers opportunities for the smaller, more specialized suppliers. Large companies can get pretty ponderous. Little ones can't and survive. A hundred years ago there were 1,333 establishments making farm equipment in this country. They were all small. Today there are exactly 1,332 — a net loss of just one in a hundred years — and 144 of them do 90 percent of the total business. Although our agriculture — in fact, our whole economy — could not be where it is today without our big efficient mass producers of farm machinery, the day of the ingenious individual and alert specialist is not done. I doubt if it ever will be.

In our political economy, demand for farm products is somewhat inflexible. As production jumps, prices slide. The point is readily reached where more production results in less total return. Only by controlling production can this result be averted for farmers in general. This does not alter the fact that efficient, individual farmers can and do make money at prices that are disastrous for the average operator. I doubt if there is another business in the world where a greater spread exists between the costs of the least and the most efficient producers. The average dairy cow, producing 6500 pounds of milk a year, is a very unprofitable animal indeed, but plenty of 50 to 100-cow herds are averaging twice that much production and are making good money.

The same thing goes for other kinds of farming. The partnership of agriculture, science and industry makes continuous cost cutting possible. The agronomist who advises farmers to use more nitrogen and phosphorus, potash or boron would have few takers, if it were not for the development and availability of the fertilizers and equipment to do the job at low enough cost to show a profit.

Fifty fair cows will produce 250 tons of milk to be handled in a year. Try doing it with a pail, and see what happens to costs! And for every ton of milk there are tons of forage, feed and manure to be handled. Try doing it with a pitch fork, and see what happens to costs! Incidentally, three-quarters of all our farm land is used for forage production, so there is quite a lot of it to work on.

There are some pretty big costs waiting to be cut, and it is going to take a large substitution of capital for labor to get the job done. The investment per worker on our 800,000 farms that take in over $10,000 per year already stands at around $35,000 as compared with about half as much per worker in industry. In the next ten years, investment per farm worker will probably double. The nature of our tax structure will tend to channel the bulk of this huge investment increase into stock and specialized equipment rather than into real estate. Old buildings will be replaced by mechanized structural systems, but more land will be leased than bought with hard-to-accumulate farm capital.

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Farm work is out of doors. Much physical labor has always been involved. A wide range of skills are acquired. The farmer is much more self-reliant than the city man. He lives in his work. His neighbors are all doing much the same kind of work. The neighbor is an important source of information and help. There is a feeling of sharing known in few other occupations. The farmer's status in his community is more a matter of his personal qualities than of his income or possessions. Although the farmer may be conservative by instinct, he is also very much of a gambler, but he gambles on his own actions and ability rather than on what someone else may do. He regards his land as a symbol of his success and independence. He has much greater loyalty to his family in which there is more tendency to work and play together than in the urban counterpart.

Beyond any shadow of doubt, the human product of our farms, the farm-reared child, has been agriculture's greatest contribution to our society. Farm boys and girls are more self-reliant, more responsible, more diligent, more honest, more socially useful than city-bred children. They are more so today than ever before. But with each passing year, there are fewer of them. This is your fault. What do you offer to supplant this grievous loss to our national stamina?

As substitutes for the cohesiveness of family farm life and the sense of responsibility it has always built, Boy Scouts, YMCA's, peace corps, youth centers, schools and churches, good as they may be, have feeble influence indeed. Urban and suburban family life, as now constituted, is far from the full equivalent of farm family life in the development of self-reliance, responsibility and the instinct to be helpful to others.

I suggest to you, my friends and partners, that the only satisfactory substitute for the building of individual responsibility and family cohesion is the building of individual responsbility and family cohesion. There is no substitute! These all-important qualities come naturally as by-products of family farm living. Off the farm, they come only from conscious effort and planning by determined and loving parents.

This is as much your problem as the concerns of your own specialty, a specialty which has aggravated and continues at an accelerating pace to aggravate the problem itself. Yours is the responsibility for solution, if you would see our national heritage preserved.

EJC Changes Address

Engineers Joint Council, federation of 24 national and regional engineering societies, has changed its address as of September 5, 1961, when it joined 18 other engineering groups in the new United Engineering Center located between 47th and 48th Streets facing United Nations Plaza in New York.

New quarters of EJC are located on the third floor of the new building and the new address is 345 East 47th St., New York 17, N. Y. The new phone is New York, PLaza 2-6800.

1962 Nuclear Congress and Atomic Exposition

The 1962 Nuclear Congress and Atomic Exposition will be held June 4 to 6 in the New York Coliseum under sponsorship of the Engineers Joint Council, Inc. Public aspects in the use of nuclear energy, as well as engineering and operational problems within the nuclear industry, will highlight discussions at the technical sessions. As in the past, there will be an exposition in addition to the program of technical papers. For information on the 1962 Nuclear Congress, contact EJC, 345 E. 47th St., New York 17, N. Y.

Opens Firm in Mexico

Formation of a new company to manufacture a complete line of automotive electrical equipment, including starting motors, generators, and ignition systems has been announced by The Electric Autolite Co., Productos Para Industries, and a group of Mexican investors. The new firm will be known as Industria Electrica Automotriz, S. A. and will be located in the Mexico City, Mexico, area. Products manufactured by the new company will be marketed under the Prestolite tradename. The company will also manufacture private label parts. According to J. J. Bohmrich, international operations vice-president, formation of the new company is a major step in expansion of the company's international position, which now includes manufacturing operations in Venezuela, Brazil, Argentina, Belgium, and Canada.

Administration Changes at University of California

C. F. Kelly

Roy Bainer

Two ASAE members assume new responsibilities in recent engineering administration personnel changes at the University of California.

Clarence F. Kelly, professor of agricultural engineering, has been appointed chairman of the department of agricultural engineering at Davis, replacing Roy Bainer who has been promoted to associate dean of engineering at Berkeley, Davis and Los Angeles, with full responsibility for developing the engineering program at Davis.

C. F. Kelly assumes his new position after more than 10 years of service on the staff. He is a native of North Dakota and earned B.S. and M.S. degrees in agricultural engineering from North Dakota State University in 1931 and 1933, respectively. He was employed by Gleaner Combine Co. in 1929, and in 1933 went to work for the State Department of Conservation in Illinois. In 1935 he accepted a position with USDA, which he held until 1950, with the exception of three years during World War II (1942 to 1945) when he served in the U.S. Navy. In 1950 he became associated with the agricultural engineering staff at the University of California and has been most active in grain storage and livestock housing. In 1956 he was made professor of agricultural engineering. He attended the Fifth International Congress of Agricultural Engineers in Brussels, Belgium, in 1958, where he presented a paper on studies and methods for protecting livestock from thermal stress in hot climates. He has been an ASAE member since 1934 and was elected a Fellow in 1958. The Farm Structures Division named him its chairman for the year 1955-56.

Roy Bainer, past-president of ASAE, has served in the agricultural engineering department since 1929 and became its chairman in 1947. He was a wheat farmer in his native state of Kansas from 1918 to 1925. In 1926 and 1929, respectively, he earned B.S. and M.S. degrees in agricultural engineering from Kansas State University. In 1945 he was consultant to the British Ministry of Agriculture and a consultant to the Army of Occupation in Japan in 1948. He also was consultant to Food and Agriculture Organization of the United Nations in Chile in 1958 and in Peru in 1961. He has been an ASAE member since 1927, was elected a Fellow in 1946 and was awarded the Cyrus Hall McCormick Gold Medal in 1948.

The engineering program at Davis, which is now the full responsibility of Roy Bainer, was authorized in 1959. From its beginning, stress was put on engineering in agriculture which included the established program and new programs in irrigation, drainage engineering and water resources, and food engineering. Enrollment in the fall of 1959 amounted to 49 students. The next year the enrollment increased to 101 and this fall there are 119 new applicants which should bring total enrollment to 185 undergraduate students plus 40 to 50 graduate students.

Although the university catalog for the coming years lists only an engineering in agriculture program, in July the Regents of the University suggested that general engineering be expanded to the Davis campus. This action requires that programs in areas of electrical, mechanical, civil, and chemical engineering will be included.

The University of California has a common lower division within the Colleges of Engineering which means that all students regardless of their major take exactly the same program for the first two years. At Davis all engineering students follow a common curriculum during their junior year in so far as possible. Specialization is done at the senior level in a program that is almost entirely elective. A student majoring in power and machinery, for example, elects 24 units from a pattern of courses that has been set up to satisfy this particular area. The same thing is true for the other programs that are offered. In this program the student and his adviser develop the course content for the senior year in whatever area the student wants to specialize. At the end of four years all graduate students receive the B.S. degree in engineering.

Agricultural Engineers in World Affairs Program

"The Engineer's Challenge in World Food Supply" was the theme for this year's meeting of the Agricultural Engineering Division, American Society for Engineering Education. "Engineering and World Affairs" was the general theme for the whole meeting of the ASEE at the University of Kentucky, June 26-30.

F. J. Welch, Assistant Secretary of Agriculture, addressed the Division and numerous guests on "Needs and Opportunities in World Food Production, Processing and Distribution." He was the featured speaker at the opening session of the Division program at 11:00 a.m., June 30. A. W. Farrall, chairman of the Division, presided at that Session. Dr. Welch credited agricultural engineering with an important place in the further development of the world's human and food resources.

The Kentucky Section of ASAE also met at Lexington on June 30. Its members and many local friends of Assistant Secretary Welch, formerly Dean of Agriculture at the University of Kentucky, were guests of the Division for various parts of its program.

In an afternoon session four speakers emphasized several of the special problems and methods involved in developing agricultural engineers and agricultural engineering as a part of the technical aid program.

Dean A. H. Willis, of the faculty of engineering, University of New South Wales, Sydney, Australia, reported on a survey of "Graduate Opinion on the Objectives of Engineering Education." Objectives rated highest by the graduates surveyed were "Ability to apply fundamental principles to new problems" and "Grasp of physical and mathematical laws." Dean Willis concluded that "... we do well if we prepare our students adequately for their first five years of professional practice and instill the ideal of self-education throughout their careers."

"The Influence of Attitudes and Cultures on Engineering Education in Other Countries" was developed by Malcom H. Jones, chief, Water Resources and Equipment Branch, Office of Food and Agriculture, I.C.A. He emphasized especially the dual problem of adapting engineering education to the current needs of any given country, and to a rapid rate of growth and change in the social and economic system of that country.

Andrew Hustrulid, University of Minnesota, pointed out special considerations which enter into the guidance of students from other countries who come here to study. His paper was on "Educational Needs of Foreign Students Majoring in Agricultural Engineering." In particular he dealt with selection, language problems, deficiencies in preparatory education, laboratory work, thesis work related to a problem in

(Continued on page 504)

M. Ronning

W. E. Garner

F. W. Bennett

D. T. Kinard

Martin Ronning has been elected to the board of directors of Ronning Corp., Minneapolis, Minn., as director in charge of new product development. He was formerly chief engineer of the Power Machinery Division of Minneapolis-Moline Co. Mr. Ronning was awarded the Cyrus Hall McCormick Medal in 1956 for exceptional engineering achievement in agriculture.

Warren E. Garner has been promoted from research agricultural engineer to engineer-in-charge of the USDA Southeastern Cotton Ginning Research Laboratory at Clemson, S. C. Prior to joining the laboratory staff in 1955 he served nearly 10 years as agricultural engineer on the staff at the University of Georgia.

Francis W. Bennett advises that he has been transferred by the International Cooperation Administration from Elobeid, Sudan, to Colombo, Ceylon. His new assignment includes living and working on a large government research station in the dryland area near Anuradhapura, where he is agriculture equipment specialist. His duties include acting as advisor on tractor mechanization and in the service training of the local staff.

Drayton T. Kinard, head, agricultural engineering department, University of Florida, recently was awarded the honorary degree of State Farmer by the Florida Association of Future Farmers of America.

Henry M. Marks and **Robert W. Dye** are now engaged in the consulting business under the name Agtrace (agricultural growth through rational application competently engineered) in Indianapolis, Ind. Both were previously associated with Farm Fans Inc.— Mr. Marks in sales and Mr. Dye as chief engineer.

Halver M. Skinner, associate professor of agricultural engineering, Montana State College, is on a two-year USOM assignment in Paraguay in connection with a contract which the College has in that country.

Joseph T. Kulhavy has been transferred from the Rock Isand (Ill.) Works of J. I. Case Co., where he was assistant chief product engineer, to its Clausen Works in Racine, Wis. In his new position as project engineer in charge of engine design he is responsible for all engine design for the company.

Cecil S. Bryan, formerly irrigation engineer at the ICA Institute of Inter-American Affairs, Bogota, Colombia, South America, has been transferred to San Salvador. He is assigned with USOM to El Salvador as agricultural engineering advisor to the Ministry of Agriculture.

Rome H. Mickelson has been transferred and promoted from his position of agricultural engineer at the USDA Southwestern Great Plains Field Station, Bushland, Texas, to agricultural engineer (research) at the U.S. Central Great Plains Field Station at Akron, Colo. His new position is a part of the moisture conservation investigations of the Northern Plains Branch and involves research on the engineering phases of water management on the dryland soils of the central plains.

Roger E. Walters has accepted a position with the USDA Agricultural Marketing Service as agricultural engineer. He will be located at the University of Georgia, where he will work on cooperative research in poultry processing plants, equipment, and facilities. He formerly was a member of the University of Georgia staff as assistant agricultural engineer.

Paul D. Rodgers, associate professor of agricultural engineering, University of Georgia, has been appointed state chairman of the Committee for Engineers in Education by the president of the Georgia Society of Professional Engineers.

James B. Uhl has accepted a position in the engineering department of the York Division of Borg-Warner Corp. in York, Pa. Previously, he was research assistant on the agricultural engineering department staff at Ohio State University.

Robert M. Peart has joined the staff of Purdue University as an associate professor. He will teach and do research in the materials handling area. He formerly was assistant professor on the agricultural engineering department staff at the University of Illinois.

Gerald G. Williams is now associated with Tennessee Valley Authority at Wilson Dam, Ala. He previously was a soil scientist with the Soil and Water Conservation Research Division of the USDA Agricultural Research Service in Georgia.

Karel Klima, formerly a research metallurgist for International Harvester Co., has accepted the position of mechanical research engineer with the Mechanical Test Laboratory of Victor Mfg. & Gasket Co.

William H. Griffin, Jr., who has been in the contracting bsuiness in Tennessee, has accepted the position of field representative with Kentucky Rural Electric Cooperative Corp. in Louisville, Ky.

Reorganization of committees within the Farm Group of Edison Electric Institute for the purpose of supervising the "Farm Better Electrically Program" has involved the following ASAE members:

Lyman H. Hammond, manager of rural development, New York State Electric and Gas Corp., continues as chairman of the Farm Group.

David N. Stiles, farm sales manager, The Connecticut Light and Power Co., has been named chairman of the Farm Development and Research Committee.

Wayne G. Russell, rural sales promotion supervisor, Wisconsin Power and Light Co., has been appointed to the chairmanship of the Farm Sales Committee.

Earl R. Heacock, rural engineer, Central Illinois Public Service Co., has been made chairman of the Farm Youth Committee.

NECROLOGY

Byron B. Robb, professor emeritus of agricultural engineering at Cornell University, died on July 8 at Tompkins County Hospital, at the age of 78, following a long illness. A native of New York, he was born on a farm near Webster on August 8, 1882. He had the distinction of being Cornell's first student in agricultural engineering, receiving a B.S. degree in 1911 and an M.S. degree in 1913. After graduation he became an instructor of agricultural engineering at Cornell and from 1945 to 1947 he was head of the agricultural engineering department. He retired on June 30, 1950.

B. B. Robb

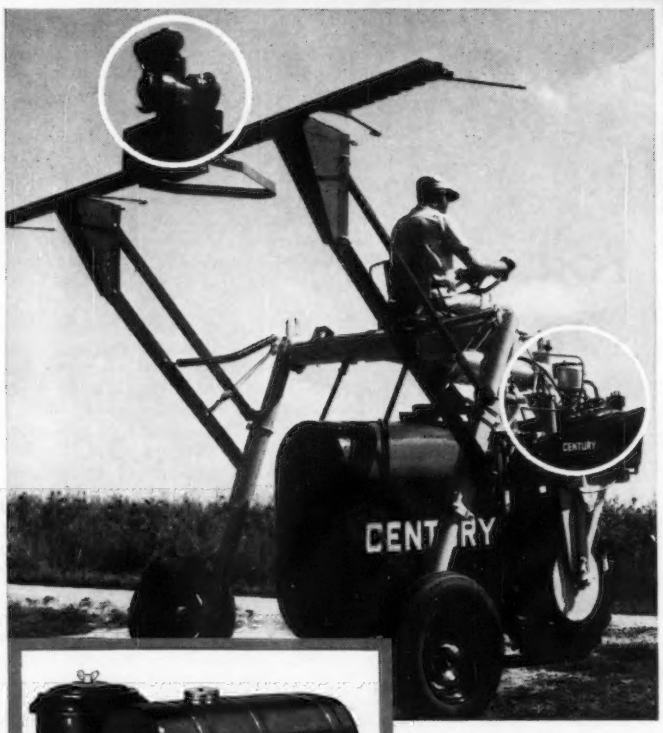
Mr. Robb was largely responsible for the development of extension work in the agricultural engineering department and was project leader until 1935. He pioneered in several fields of extension teaching, notably in land drainage and in care and repair of farm machinery and household equipment and developed a course in household mechanics for women which included home water supply, pumping and plumbing, electric wiring and motors, care and adjustment of sewing machines, and automobile maintenance. In 1956 Cornell named its new agricultural engineering building in honor of Professor H. W. Riley, who started the department, and for Professor Robb, its first student and assistant.

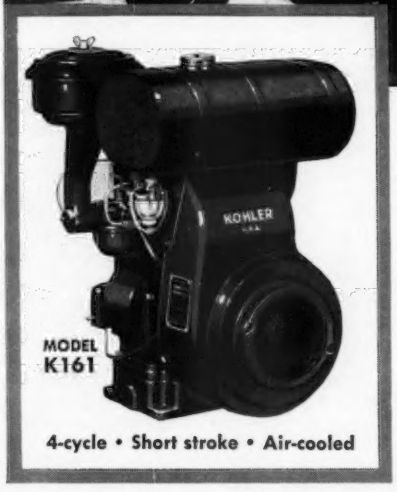
He had been an ASAE member since 1921, was made Life Member in 1957, and was a past-chairman of the North Atlantic Section. He had been a member of the Grange in Webster, N.Y., for more than 50 years. He also was a 32nd degree Mason, receiving his 50-year pin this past winter. He also held membership in Acacia, Phi Kappa Phi, and Epsilon Sigma Phi.

He is survived by his wife, Georgia, and two daughters, Mrs. Ronald E. Bowman and Mrs. Paul E. Newman.

Work is play with a Bolens Ride-A-Matic, popular riding tractor powered by a Kohler K161.

KOHLER ENGINES





4-cycle • Short stroke • Air-cooled

This versatile unit manufactured by Century Engineering Corp., Cedar Rapids, Ia., has two Kohler engines—a K662 for the self-propelled tractor, a K91 to power the corn topper attachment.

Rugged load luggers!

Smooth-running, cost-saving efficiency of Kohler engines makes light work of heavy loads . . . steps up staying power of farm and garden equipment.

Hot spark insures snappy starting in all weather . . . Large bore and short stroke design cut friction, increase power, prolong engine life . . . Balanced crankshaft reduces vibration.

Authorized distributors and dealers, nation-wide, provide prompt, skilled service; stock and install parts.

Manufactured for over 40 years, Kohler engines are conservatively rated, recognized for reliability.

From 4 to 24 H.P. • Write for illustrated booklet.

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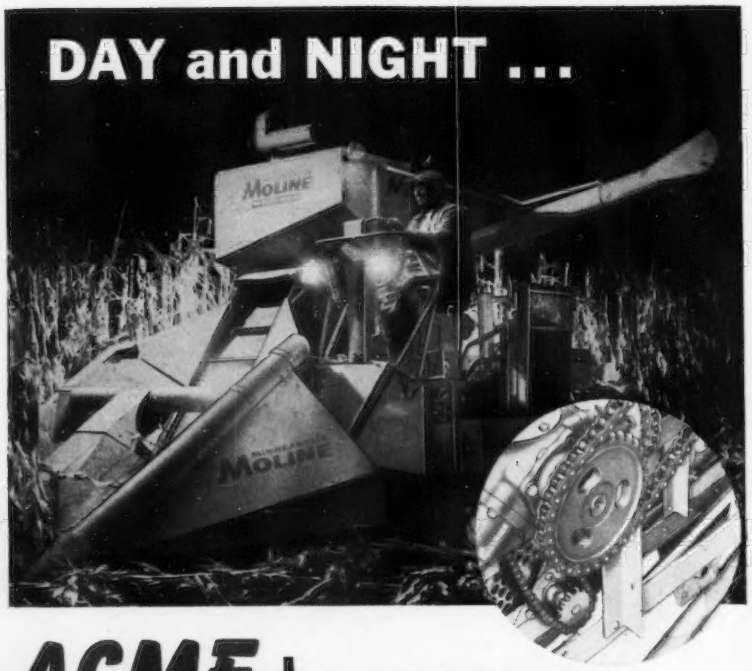
ENAMELED IRON AND VITREOUS CHINA PLUMBING FIXTURES • ALL-BRASS FITTINGS • ELECTRIC PLANTS • AIR-COOLED ENGINES • PRECISION CONTROLS



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ACME's rugged, dependable and economical roller chains never let you down — even if you have to operate your farm equipment day and night. The strength and endurance built into ACME's agricultural chains mean fewer breakdowns and less maintenance cost. They are engineered to handle the heaviest loads under the most arduous service conditions — without friction loss or slippage.

Insure the successful operation of your farm machinery. Call ACME's Engineering Department, they will be glad to place their years of agricultural equipment experience at your disposal. There is no obligation on your part for this service.

Inset shows the main drive and other auxiliary roller chains for snapping rolls and husking raddles on Minneapolis-Moline Uni-Picker-Sheller.

Acme Chain Corporation
HOLYOKE MASSACHUSETTS

Write Dept. 9-F for new ill. 100 page catalog with engineering section.

RELIABLE CHAIN DRIVES FOR ALL INDUSTRIES

ROLLER CHAINS, SPROCKETS, CONVEYOR CHAINS, FLEXIBLE COUPLINGS, ATTACHMENTS. (Special and Standard)

. . . News

(Continued from page 501)

the student's home country, vocational and in-service training, and the faculty advisor's function, including helping the student deal with any of a wide variety of personal problems.

In a prepared discussion, Carl W. Hall supplemented Dr. Hustrulid's remarks with special attention to the faculty advisor's function in helping students from other countries to overcome their adjustment problems. He pictured four phases in the adjustment process. If the student, with appropriate guidance, can get through the emotional low of the second or adaptive phase, his educational experience is usually successful, Dr. Hall said.

Speaking from the viewpoint of a former student from abroad, Nuri N. Mohsenin, of the Pennsylvania State University, reported on "Agricultural Engineering Education and Its Relations to Economic Developments in Underdeveloped Countries." His concluding point was that "Most of the underdeveloped countries of the world are inherently rich. Their major technical problem . . . is the under utilization of physical and human resources. To develop these countries to their potentialities, agricultural engineers have tremendous opportunities and they must take a leading role."

Discussion in this session further brought out a strong feeling that more of the training of native agricultural engineers for service in their home countries will have to be done in those countries, close to the conditions and problems with which they will work.

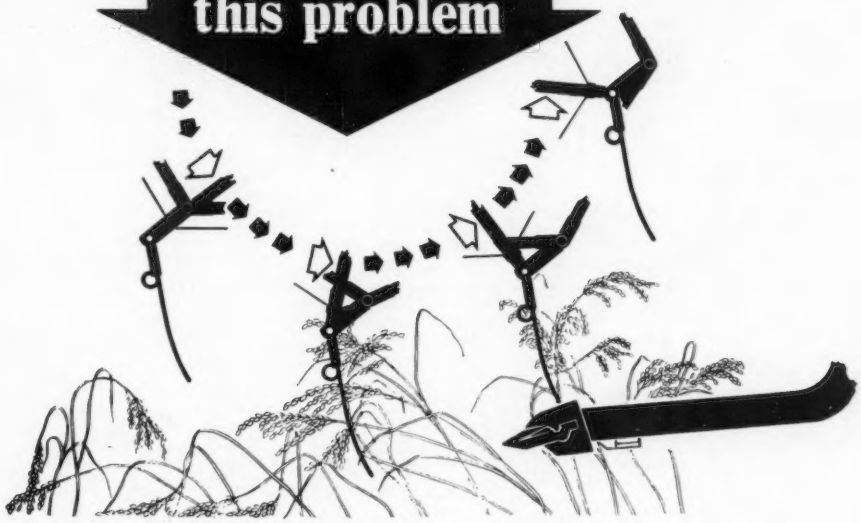
Blaine F. Parker, program chairman for the meeting, presided at this session. At its conclusion he turned the meeting back to Dr. Farrall, chairman of the Division.

Chairman Farrall called a short business meeting of the Division. As the first item of business he expressed the appreciation of the Division to Dr. Parker for his work as program chairman, and to the University of Kentucky for its courtesies as host to the meeting. Other items taken up were the proposed division constitution and by-laws, time and place of the meeting next year, and the program chairman assignment for next year. Chairman Farrall introduced J. B. Liljedahl, newly elected chairman, and turned the Division over to him.

Entertainment features of the meeting included a talk on "Horse Country" by James M. Todd, Lexington attorney, at the Friday noon luncheon. That evening the Division members, guests, and families enjoyed a chicken barbecue supper at the Spindletop estate recently acquired by the University of Kentucky Research Foundation for development as a research and conference center. A conducted tour through the mansion proved a high point of interest. A "Bluegrass Tour" the following morning started at the Agricultural Engineering Building and included the home of Henry Clay, the Mary Todd Lincoln home, and blue grass horse farms.

The Agricultural Engineering Division also was a joint sponsor with other divisions in sessions on "The Mutual Responsibilities of Publishers and Authors," "Research on Engineering Faculty Utilization," and "Engineering Teacher-Student Relationships."

let us help you solve this problem



A pick-up type reel is an important contribution to the performance of any harvester — and the design of the right harvester-matched reel is a specialized problem. Why not employ our engineering skill and background to help in this important phase of your overall harvester design? Drawing on our experience of over 25 years and many exclusive patents, we can engineer a pick-up reel tailored to the other design characteristics of your machine, and the crops and areas being served. As a leading producer of pick-up reels, we have the plant capacity and automated production lines to assure you of delivery at reasonable costs. Let us conserve your valuable engineering time.

Also designers and manufacturers of harvesting machines for green peas, spinach, lima beans, mint, greens, pumpkins and other specialized crops.

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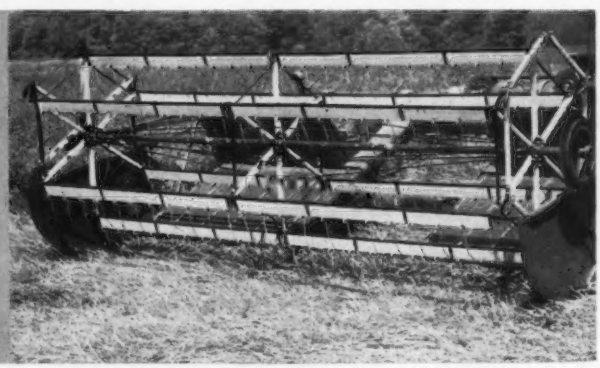


Georgia Section

The Georgia Section elected the following slate of officers for the ensuing year at its June meeting held at Jekyll Island: J. L. Butler, chairman; O. W. Ginn, vice-chairman; and A. H. Bennett, secretary-treasurer.

Minnesota Section

The fall dinner meeting of the Minnesota Section will be held on September 28 at Normandy Village in Minneapolis. Ladies will be special guests at this meeting. Martin C. Briggs of Minneapolis, a retired manufacturer, will be the speaker of the evening. He will speak on "Diamonds in Your Own Back Yard."

South Carolina Section

The South Carolina Section held its annual summer meeting August 25, 26 and 27 at the FFA Camp, Cherry Grove Beach. A business meeting was held on Friday and a highlight of the three-day meeting was the banquet on Saturday evening. The meeting was a family affair and the recreational facilities of the camp were enjoyed. Activities included swimming, deep sea fishing, a moonlight cruise, softball, shuffleboard, ping pong, square dancing, movies, and a bridge tournament.

Washington, D. C.-Maryland Section

The Washington, D. C.-Maryland Section held a luncheon meeting on September 8 in the USDA South Building, Washington, D. C. National President Byron T. Virtue, consultant, Bearings Division, The Torrington Co., Torrington, Conn., was the featured speaker, his topic being "ASAE Headquarters Personnel and Functions." J. L. Butt, executive secretary of ASAE, also attended the meeting and met with the Local Arrangements Committee for the 1962 Annual Meeting.

Connecticut Valley Section

The Connecticut Valley Section is sponsoring an educational booth at the Eastern States Exposition to be held from September 16 through September 24. The booth will be manned by section members during the week-long exposition.

EVENTS CALENDAR

September 24-26 — *International Congress of Automation,* Turin, Italy. For details, write to the Associazione Nazionale per L'Automazione, Plazza Belgioioso 1, Milano, Italy.

September 25-28 — *The American Welding Society Fall Meeting,* Adolphus Hotel, Dallas, Texas. Details may be obtained from AWS, 33 W. 39th St., New York 18, N. Y.

September 25-28 — *Industrial Building Exposition and Congress,* New York Coliseum, New York, N. Y. Contact Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N. Y. for details.

October 4-6—*1961 Annual Meeting, Southern Farm Equipment Manufacturers,* Ponte Vedra Beach, Fla. For details write to SFEM, P.O. Box 9, Chamblee, Ga.

October 16 — *Annual Meeting of the American Society of Safety Engineers,* observing its 50th anniversary, Waldorf Room, Conrad Hilton Hotel, Chicago, Ill. Details may be obtained from ASSE, 5 N. Wabash Ave., Chicago 2, Ill.

October 19 — *Fifth International Course in Hydraulic Engineering,* Delft, Netherlands (for eleven months). Information may be obtained from Netherlands Universities Foundation for International Co-Operation, 27 Molenstraat, The Hague, Netherlands.

October 19-20 — *1961 National Conference on Industrial Hydraulics,* Sherman Hotel, Chicago, Ill. Information may be obtained from Illinois Institute of Technology, 35 W. 33rd St., Chicago 16, Ill.

October 19-21 — *National Society of Professional Engineers Fall Meeting,* Hotel Roanoke, Roanoke, Va. For further information contact NSPE, 2029 K St., N.W., Washington 6, D. C.

October 20-22 — *Eastern Lawn and Garden Trade Show,* New York Coliseum, New York, N. Y. Write to ELGTS, Suite 1103, 331 Madison Ave., New York 17, N. Y., for information.

October 22-25 — *Centennial Nutrition Conference,* Hotel Muehlebach, Kansas City, Mo. Contact Midwest Feed Manufacturers' Association, 20 W. Ninth St. Bldg., Kansas City 5, Mo., for details.

October 22-27 — *Dairy Industries Supply Association, International Association of Ice Cream Manufacturers, and Milk Industry Foundation Conventions,* Washington, D. C. For further details contact T. L. Jones, Room 512, 1145 19th St., N.W., Washington 6, D. C.

November 2-3—*Agriculture-Petroleum Seminar,* Louisiana State University, Baton

(Continued on page 510)

ASAE MEETINGS CALENDAR

September 25 — Baton Rouge Section, Agricultural Engineering Auditorium, Louisiana State University, Baton Rouge, La.

September 28 — Minnesota Section, Normandy Village, Eighth St. and Fourth Ave., Minneapolis, Minn.

September 28-29 — Hawaii Section, Coordinating Conference, island of Maui.

October 6 and 7 — Ohio Section, Ohio State University, Columbus, Ohio.

October 18-20 — Pacific Northwest Section, Boise Hotel, Boise, Idaho.

October 20-21 — Pennsylvania Section, Pennsylvania State University, University Park.

October 28—Michigan Section, Michigan State University, East Lansing.

November 17—Quad City Section (place to be announced later).

December 12-15 — Winter Meeting, Palmer House, Chicago, Ill.

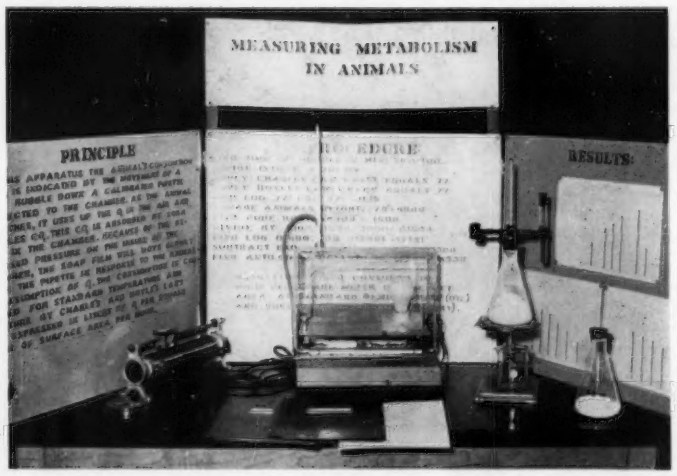
June 17-20 — Annual Meeting, Mayflower Hotel, Washington, D. C.

Note: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

AE JETS Entry Wins Superior Award

A total of seven agricultural engineering projects were entered in the 9th Annual National JETS (Junior Engineering Technical Society) Project Exposition, held May 12 to 14 at Michigan State University, East Lansing. As a cooperating organization, ASAE has indicated its support of the JETS activity in encouraging engineering training among high school students by sending a one-year subscription to Agricultural Engineering to each student entering a project in the agricultural engineering category. Winners of Superior Awards also receive copies of the Transactions of the ASAE for the current year, and other ASAE publications closely related to the theme of the student's entry.

Shown at right is a Superior Award winning exhibit entered in the agricultural engineering category, by Keith Belser, A. C. Flora High School, Columbia, S. C. His project involved the design, construction, and practical usage of a metabolism cage for measuring metabolism in animals. The project involved measurement of metabolism in terms of liters of oxygen consumed per hour per square meter of surface area at standard temperature and pressure. Experiments with live hamsters were conducted on the effects of variation of water supply, food supply, and living temperature on metabolism. Results were then analyzed and recorded on graphs to show their relationships.



Before entry in national competition, Belser's project had an impressive list of prizes won on the high school, city, regional, and state levels, which was climaxed by winning the grand prize in the state (South Carolina) JETS Club Science Fair.

INTRODUCING INDUSTRY'S MOST COMPACT
60-HP HEAVY-DUTY AIR-COOLED ENGINE
• 4-cycle 4-cylinder V-type
• 36 hp at 1400 rpm to 60.5 hp at 3000 rpm
• 154 cu. in. displacement
• 7.1:1 compression ratio
• weighs only 521 pounds dry
NEW 60 HP. WISCONSIN MODEL V-460D WITH VALVE-IN-HEAD DESIGN!

Now Wisconsin offers you more power . . . amazing compactness...greater efficiency and economy . . . and simplified upkeep.

At 60 hp, the new V-460D is the most powerful V-4 in the Wisconsin line. It's precision-built for all-weather dependability and long life in severe applications. And it's designed to boost the customer appeal of the power equipment you build.

You can cut design and production costs, because this 521-pound compact requires less structural support. You can up the payload and work capacity of your equipment — make it lighter and easier to handle — and more economical for users to own, operate and maintain.

Valve-in-head design and higher compression afford greater fuel economy with *regular* gasoline. They provide cooler and more efficient engine performance—and simplify upkeep. Even removing a cylinder for piston or ring replacement takes only minutes.

Check all the benefits and savings the V-460D offers you and users of your mechanized equipment. Better still, let us tailor it for your self-propelled, portable, or stationary applications. For more information, get Bulletin S-282. Write to Dept. 0-41.

CHECK THESE FEATURES:

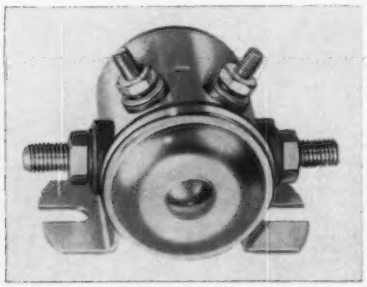
- Center main roller bearing and tapered roller end main bearings to absorb all thrusts.
- Stellite-faced exhaust valves and positive rotators for up to 500% longer valve life.
- Controlled pressurized lubrication for full-time oiling to all working parts.
- Automatic protection against overheating and servicing neglect.
- 12-volt electric starter with distributor ignition.
- Wide range of optional equipment and accessories.

WISCONSIN MOTOR CORPORATION
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

O-338

New Solenoid Switch

Clum Mfg. Co., 607 W. National Ave., Milwaukee, Wis., has introduced a new silver-contact solenoid switch (100-amp



load, 500,000 cycles) for industrial and marine application in engines and motors using standard 12-v current. The new switch is designed to close and seal at 60 percent of rated voltage in any position, at normal room temperature. Its release voltage is said to be 15 percent of rated voltage.

New Process and Design for Tractor Engine Pistons

M & W Tractor Products, Anchor, Ill., has developed what is described as "magna-seal" treated sleeves and turbo-dome pistons

designed to increase tractor power and cut ring drag. The new coating reportedly absorbs oil, thereby offering protection against scuffing and ring wear. The manufacturer claims that the new high-turbulence piston design increases horsepower 20 to 30 percent and that triple-seal rings stop hot blow-by to minimize flashing and build-up of carbon deposits.

Pump Idle Control

Homelite, Port Chester, N. Y., has developed a new automatic idle control accessory for pump engines when water drops below the suction line strainer. It also brings the engine up to full speed when water level rises. In operation a diaphragm (vacuum-sensing device) is connected through a tube to the suction elbow. When water drops below the suction hose strainer and vacuum in the line is lowered, the diaphragm relaxes causing the spring-loaded throttle to move into idle position. When seepage water covers the strainer and vacuum increases, the diaphragm operates, pulls the throttle rod and brings the engine up to full pumping speed.

New Drier Introduced

Harvestall Industries, Inc., New Hampton, Iowa, has introduced a new mobile intermediate-size drier, said to combine the ad-

vantages of instorage and batch drying systems. The new drier has a 1000-bu drying capacity using temperatures not above 130 F. It is reported that the unit may be used for drying partial bulks of grain by use of a horizontal hydraulic-powered leveling auger with an adjustable V-shaped device giving control in metering the grain within the drier. This auger is reversible permitting fill from either end or center. A bottom unloading auger removes dry grain to a truck or storage bin.

Seat Design for Comfort

Bostrom Corp., 133 W. Oregon St., Milwaukee, Wis., has developed a foam cushioned tractor seat produced by integrally

molding foam urethane to a vacuum-formed synthetic rubber seat cover. The cover material is identical to that used on automobile tire whitewalls and the foam seat, which is fastened to a metal pan by means of grommets and a plastic welt, is contoured for comfort and ease of movement. Emphasis is placed on aeration and cooling. The seat is deeply fluted and the cover material has a pebble finish of many tiny impressions which channel air from larger grooves. Two ¾-in. holes are located in the lowest section of the seat for drainage and further aeration.

Rotary Scythe

The Mathews Co., Crystal Lake, Ill., has introduced a new innovation in hay mowing machinery called a rotary scythe. The new

machine combines a power driven horizontal rotor with 24 hinged, scythe blades, a free-turning roller with frictionless bearings, and an adjustable crimping shield. Mowing a 6-ft width, the front roller bends the hay forward, so the curved scythe blades can clip stems at their base. The plants are lifted up stem first, with the leafy parts remaining in contact with the roller to prevent further cutting. They form a mat which is crimped by the adjustable shield, and pass to the rear for deposit on the ground in swaths or windrows.

Tank-Type Beet Harvester

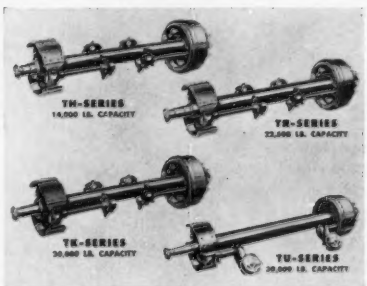
Deere & Company, 3300 River Dr., Moline, Ill., has announced a new tank-type beet harvester designed for one-man oper-

ation at 5 mph or faster. The new harvester can be equipped with either two or three wheel-type digger units for digging three 20 to 22-in. rows or two 20 to 36-in. rows. Either solid-rim or spade-type wheels are available. Power can be supplied by a 40-dhp tractor with two remote hydraulic cylinders.

The unit has a 3½-ton tank and can be unloaded — either on the go or standing still. Unloading is controlled by the tractor operator through an electric clutch. The cleaning bed of star wheels is 52 in. wide at the front and 36 in. wide at the rear. The elevator and horizontal conveyor are also 3 ft wide.

Adds to Axle Line

Rockwell-Standard Corp., Transmission and Axle Div., Detroit 32, Mich., has added three new series of trailer axles to its line.



The enlarged line, including the TK Series in the 20,000-lb capacity range, now provides a capacity range from 14,000 to 30,000 lb. The TH Series of 14,000-lb capacity is designed to accommodate both single and dual wheel applications for operation of such trailer types as vans, low beds, auto haulaway units and other wide-track applications. The TR Series provides for loads up to 22,500-lb capacity, and the TU Series is designed for 30,000-lb capacity loads. A 12-page descriptive folder may be obtained by writing to the company.

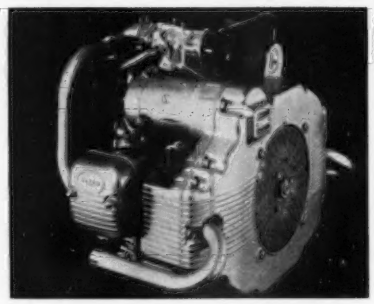
Variable Volume Hydraulic Pump

Gar Wood Industries, Inc., Wayne, Mich., has introduced variable volume piston-type hydraulic pump called the Variacs. According to the manufacturer, possible applications for the new pump include the operation of hydraulic components on

heavy duty equipment, rail and industrial installations and for hydra-static drive of self-propelled machinery. It is further reported that the pump works only on demand and that no oil is pumped in hold position. A piston assembly in the unit contains nine pistons which rotate with the cylinder block. When the piston assembly is tilted, each piston draws oil into the cylinder block during one half of the rotation and forces it out during the other half. The more the piston assembly is tilted, the greater the volume. At relief setting, the piston assembly automatically returns to neutral thus stopping the flow of oil.

Two New Die-Cast Aluminum Engines

The OMC Engines and Equipment Div., Outboard Marine Corp., Waukegan, Ill., has announced two new lightweight die-cast



aluminum engines. The engines are 1 and 2-cylinder, 4-cycle, air-cooled models rated at 9 and 18 hp, respectively, for a wide variety of uses, including industrial, railroad, construction, agricultural, petroleum, and marine. According to the manufacturer, vibration has been reduced by offsetting the cylinder of the single cylinder engine 35 deg off the horizontal and by having the two cylinders of the twin-cylinder engine opposing each other. Specifications are as follows: The 9-hp single-cylinder model has a 3½-in. bore and 2¼-in. stroke with 15 ft-lb maximum torque at 2500 rpm and weighs 78 lb. The 18-hp twin-cylinder model has a 3½-in. bore and 2¼-in. stroke with 32 ft-lb maximum torque at 2500 rpm and weighs 126 lb.

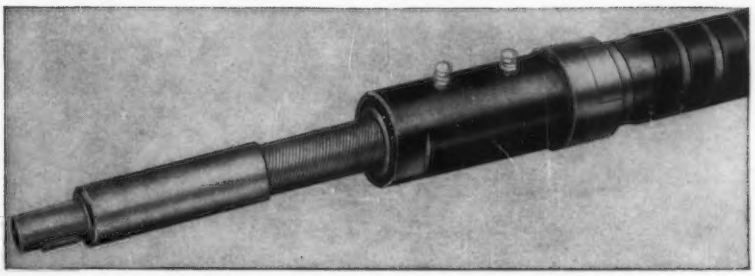
Irrigation Control Device

United States Steel Corp., 525 William Penn Place, Pittsburgh 30, Pa., has announced the start of extensive field tests on

a new, all-steel irrigation water control device. The new structure features three preformed components that can be assembled into a variety of sizes and shapes, and is said to be flexible enough to fit a small garden furrow or large ditch. According to the report the device is light in weight for ease in moving from place to place, yet has strength to provide a permanent structure if desired; adaptable to most irrigation structural needs, including diversions for single or multiple turn-outs, check gates and drops; adjustable for exact control of water flow in nearly any size of ditch; and adaptable to

(Continued on page 512)

HOW TO SELECT FLEXIBLE SHAFTING FOR POWER DRIVE APPLICATIONS



1¼-inch STOW Power Drive flexible shaft with core assembly pulled out of casing.

For Power Drive applications, the following factors must be considered:

1. Torque (Lb. In.) to be transmitted. (The starting torque should be used in making selections).

2. Operating Speeds (RPM)—If the maximum speed is higher than the rated speed, torque ratings in the table below do not apply. To find the torque capacity for flexible shafts operating at speeds higher than the rated speeds, multiply the maximum dynamic torque capacity by the rated speed, and then divide by the operating speed. (See example).

3. Operating Radius—In making the selection from the table below, the radius of the smallest bend in the flexible shaft should be used.

Ratings — The ratings for flexible shafts shown in the table below apply under the following conditions:

1. When the flexible shaft is adequately supported by clamps along its length. (For unsupported shafts, multiply the calculated torque by a safety factor of 1.6—see example below)

2. When the flexible shaft is operated in the wind-up direction, which tends to tighten the outer layer of wires. (Flexible shafts operated in the unwind direction will transmit only about 60% of the rated torque).

3. When the flexible shaft is in continuous operation. Note: **the ratings are based on temperature rise. When the operation is intermittent, the ratings in the table may be exceeded. Consult Stow Engineers for specific recommendations.**

RATED SPEED R.P.M.	MAXIMUM DYNAMIC TORQUE CAPACITY (LB. IN.) STRAIGHT AND CURVED SHAFTS RADIUS OF CURVATURE IN INCHES									Wgt./ C. Ft.	Core Dia.	Core No. and Type	Shaft Size
	50 to Strgt.	25	20	15	12	10	8	6	5				
4,500	2.4	2.2	2.0	2.0	1.92	1.9	1.7	1.5	1.25	3.0	.124/.128	2049 MH	13
3,800	7.0	6.4	6.0	5.8	5.4	5.0	4.6	3.6	2.0	4.5	.148/.152	2081 MH	15
2,900	9.4	8.6	8.0	7.6	7.0	6.6	6.0	4.8	3.4	7.0	.185/.189	5108 MH	19
2,500	22.0	20.0	18.8	17.6	16.0	15.0	12.6	10.8	9.0	12.5	.247/.252	8924 MH	25
1,800	30.0	28.0	26.4	25.0	23.0	21.0	18.0	14.0		20.0	.308/.313	8925 MH	31
1,800	33.8	31.5	29.7	28.1	25.9	23.6	20.2	15.8		20.0	.308/.313	8969 T	31
1,800	36.0	33.0	31.6	30.0	28.0	26.0	22.0	18.0	11.0	21.0	.324/.329	2034 A	31
1,500	80.0	66.0	63.0	58.0	51.0	46.0	37.0	22.0		28.5	.368/.374	2035 A	38
1,500	60.0	54.0	50.0	46.0	42.0	38.0	30.0	24.0		29.0	.387/.393	8970 MH	40
1,500	90.0	81.0	75.0	69.0	63.0	57.0	45.0	36.0		29.0	.387/.393	8971 T	40
1,150	136.0	110.0	104.0	94.0	80.0	72.0	56.0			50.5	.497/.503	8999 A	50
1,150	148	124	110	92	72	56				53.5	.505/.511	6940 T	50
900	248	200	176	124	84					78.5	.610/.618	6997 T	63
900	220	204	192	180	152	130				80.5	.630/.638	7731 A	63
750	340	224	156	76						117	.747/.753	2056 T	75
600	760	520	420							205	.998/1.004	2057 T	100
440	1,500	720								343	1.298/1.304	2058 T	125

EXAMPLE — How to use the table:

The problem is to transmit ½ H.P. at 1700 RPM through an unsupported flexible shaft in a 25" radius, estimated starting torque 150% of normal operating torque.

1. Calc. Torque (lb. in.)—

$$\frac{HP \times 63000}{RPM} = \frac{.5 \times 63000}{1700} = 18.5$$

2. Correction factor for starting torque 1.5 x 18.5=27.75

3. Correction factor for unsupported shaft 27.75 x 1.6 = 44.4 lb. in.

4. Refer to Table above. Read downward in column under 25" radius until you find a core having a rating of at least 44.4 lb. in. In this case we find that core No. 8970 is rated 54 lb. in. at 1500 RPM. Since the given speed is 1700 RPM, multiply 54 by 1500 and divide by 1700. 54 × 1500 ÷ 1700 = 47.6 lb. in. (rated torque at 1700 RPM). Therefore, Core No. 8970 is correct.

STOW

For Engineering Bulletin No. 570 and a free torque calculator, write

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CHECK POINTS

by J. L. BUTT

THE TECHNICAL COORDINATOR

BY NOW, all members should have received the special notice advising of the ASAE Board of Directors' decision to add a Technical Coordinator to the headquarters staff. The notice also informed all members that adjustments were made in the annual dues schedule for certain age categories, effective January 1, 1962. Following is a more complete description of the duties of the Technical Coordinator and what this staff addition will mean to ASAE and to each agricultural engineer.

As the title implies, the Technical Coordinator will be given the responsibility of "coordinating the technical functions of the Society." At present, these responsibilities are handled by various staff members, they receive a minimum of attention, they are not well coordinated, they represent perhaps the fastest developing phase of Society work and (along with the Society's publishing, professional and educational responsibilities) they must be considered one of our major opportunities for service to the profession, to agriculture and to individual members.

Just what will the Technical Coordinator do? For one thing, he will give much closer attention to the ASAE committees than has been possible in the past. He will keep in close touch with the work of each committee, its objectives, its timetable of action, its membership, its progress toward stated objectives. As committee objectives are achieved, they will be reported promptly to the full membership — through published reports, summaries in AGRICULTURAL ENGINEERING, news releases to pertinent organizations and publications. This will serve to bring the good work of ASAE committees to the attention of all members and to others who can effectively use this information. It will help us to achieve our purpose of serving the engineering interests of agriculture — and will provide each member with additional tools and information to make him more effective in his work.

The Society's contacts with other technical societies and groups are expanding at an extremely rapid pace at the present time. Efforts are being made to try to coordinate the technical programs and activities of all engineering societies through Engineers Joint Council. Bringing all these new contacts and activities together into a coherent program to best serve the interests of the agricultural engineering profession will require close liaison with all such groups, an understanding of their procedures and organization, and an appreciation of those areas in which ASAE should be represented in cooperative work. These contacts will give our profession a stronger voice in all technical activities with which we are concerned — and will bring to each member new sources of technical data and information to further his own personal development.

An increasing amount of technical data flows through Society headquarters from foreign sources as well as from the many organizations and institutions in this country. Many of these documents have a direct bearing upon activities of certain ASAE committees or divisions. For ASAE to serve better its purpose of disseminating useful information to interested groups within the Society, it is important to select from this information that which is pertinent to ASAE and see that it is directed to appropriate committees or announced to the full membership. This will serve to broaden the scope of our information services and funnel information to the ASAE membership.

The Technical Coordinator will assume a major role in connection with AGRICULTURAL ENGINEERS YEARBOOK. The Yearbook is our medium for compiling important technical data for the benefit of each member. Its value will be increased as the productive efforts of our committees reach fruition. The Yearbook will become increasingly important and valuable as a "must" finger-tip reference piece for all engineers working in agriculture.

The Society is frequently requested by organizations, institutions, and individuals to provide certain technical information or to suggest sources of information. Heretofore, only limited attention has been given to establishment of files, reference sources, related publications or organizations, with the specific objective of being able to better handle such requests. The Technical Coordinator will give major attention to the problems associated with information collection and retrieval — one of the major problems currently facing all professional and technical groups because of the tremendous increase in number of technical papers and reports. This is one service area in which drastic procedural changes are anticipated by most engineering societies within the next decade or so. ASAE must be equipped to meet this need for the agricultural engineering profession.

The Technical Coordinator will have other responsibilities related to the technical functions of the Society, but I believe we have listed the major areas which will be given early attention. We also recognize that as we get into the program some shifts in duties or adjustments of our present concepts may be indicated. But this will serve to acquaint you with the anticipated role of the Technical Coordinator; and when he has reported for duty, either he or I will gladly receive your suggestions and recommendations concerning this area of responsibility.

Now, just how will this influence or help with respect to publications, publicity, finances, public relations, and all the other Society services? We anticipate that the addition of the Technical Coordinator will allow present staff members to concentrate their efforts toward furthering these services to members. The additional income which will be produced by the authorized increase in dues will, in addition to supporting the cost of the Technical Coordinator and his secretary, provide additional funds to support the various professional and educational services of the Society. Some of you may not realize that the Society maintains separate financial accounts for (1) Society, (2) AGRICULTURAL ENGINEERING, (3) AGRICULTURAL ENGINEERS YEARBOOK, and (4) TRANSACTIONS OF THE ASAE. Income and expenses for the Yearbook and Transactions have about broken even. Expenses for Society operations have exceeded income by several thousand dollars, while income from AGRICULTURAL ENGINEERING has exceeded expenses by approximately the same amount. Thus, in its over-all operation, ASAE has achieved its objective as a non-profit organization of holding expenses within income (with minor variations from year to year). But with respect to the internal accounting, there is need for additional income to provide the Society services demanded by the members without having to draw upon the Journal for support. The dues increase will accomplish this, permitting all Journal income to be used toward building up the Journal — and with an expanded publication, with more staff effort directed toward advertising sales, and with the additional study and attention being given to ASAE publications by the newly formed Committee on Publication Policies and Finances, we anticipate continued, and we hope accelerated, publications development in the future.

The record of the last decade or so clearly shows this rapid rate of development of ASAE and the growing importance of engineering to agriculture. The most conservative projections of this trend indicate greater opportunities in the immediate future. If we are to give direction to this development, if we are to stay "on top" of the growing demand for technical services, if we are to continue to expand the scope and work of our Society, then we must be staffed accordingly. The Technical Coordinator is your Board's way of saying "let's be on with the job to be done."

. . . Events Calendar

(Continued from page 506)

Rouge, La. Contact American Petroleum Institute, 1271 Avenue of the Americas, New York 20, N. Y., for information.

November 6 — *48th Annual Convention of the National Warm Air Heating and Air Conditioning Association,* LaSalle Hotel, Chicago, Ill. Contact NWAHACA headquarters, 640 Engineers Bldg., Cleveland 14, Ohio, for details.

November 8-10 — *48th Annual Convention of the National Warm Air Heating and Air Conditioning Association,* LaSalle Hotel, Chicago, Ill. Details may be obtained from association headquarters, 640 Engineers Bldg., Cleveland 14, Ohio.

November 13-17—*National Electrical Manufacturers Association Annual Meeting,* Traymore Hotel, Atlantic City, N. J.

November 17-23 — *Farm-City Week.*

November 27-30 — *Annual Meeting of the American Society of Agronomy,* Sheraton-Jefferson Hotel, St. Louis, Mo. Write to ASA, 2702 Monroe St., Madison 5, Wis., for information.

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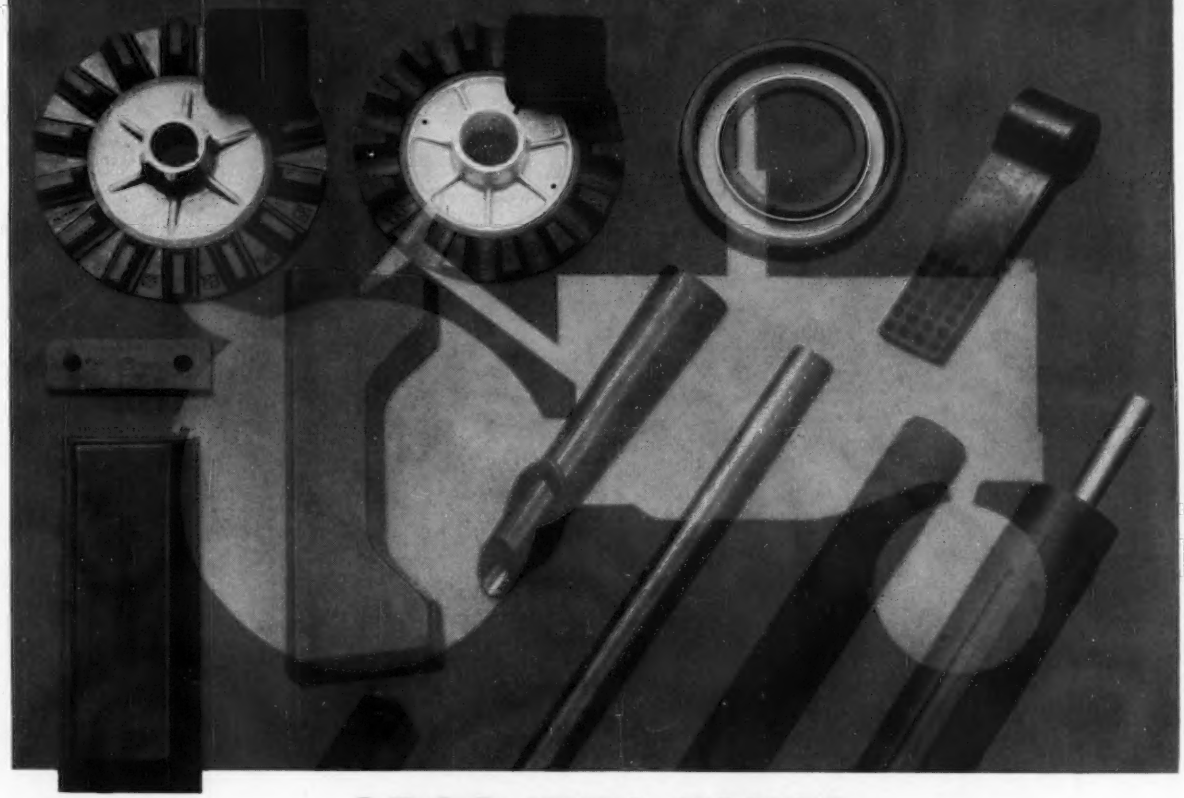

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. . . New Products

(Continued from page 509)

any type of soil or land conditions. The three basic module units from which various types and sizes of structures can be assembled include flat panel pieces 6 in. wide and varying in length according to a specific need. These can be used to form all parts of the structure, except the check gate itself and the angle frames into which the gate fits.

New Photoelectric Control Automatically Switches Lights

Fisher-Pierce Division, Sigma Instruments, Inc., 170 Pearl St., South Braintree 85, Mass., has developed a completely automatic control that turns lights on when natural light fades to a certain intensity level, and turns them off when natural light reappears at dawn. In addition, lights may be turned off manually at any time by pressing a button on the control box. The lights will remain off until the next evening, when the control will automatically turn the lights on. Lights can also be turned on during the daytime by pressing another button.

New Hydraulic Valves and Conversion Kits

Hydraulic Unit Specialties Co., Waukesha, Wis., announces the development of a line of standard multi-plunger valves that can be adapted to a wide variety of applications without further engineering. The new line consists of two series, each with four models in one to four plungers with three plunger end conversion kits available for each series, permitting a wide range of adaptations to individual control needs.

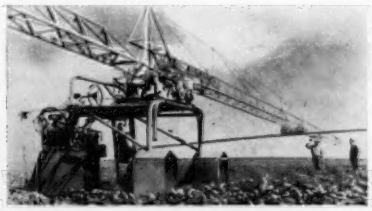
The new Series 4170, with 23-gpm capacity, and Series 4300, with 41-gpm capacity, are available with N.P.T. ports, completely balanced design with plungers sealed at both ends. They provide multi-position control, either three or four positions, with spring return to neutral. Ready conversion of the valve from standard spring return to neutral to four control positions (raise, lower, float and neutral) is provided for with or without detent. In addition, special lever control kits are available for varying arrangements. Double-acting cylinders are standard, but these can be converted to single-acting where required.

New Ditcher

Farmers Implement Mfg. Co., Shoshone, Idaho, has added a PTO-operated ditcher to its line of farm equipment. The unit has been designed not only for making ditches for irrigation or drainage, but also for cleaning established ditches. Other uses include terracing and digging drainage ditches and ditches for draintile. The new tool attaches to the standard 3-point hitch and has special wear-resistant replaceable cutting blades and deflector control to place dirt on the edge of the ditch or spread it out up to 50 ft. It is designed to dig a ditch with a round bottom 24 in. wide and up to 48 in. deep.

Irrigation Pipe Mover

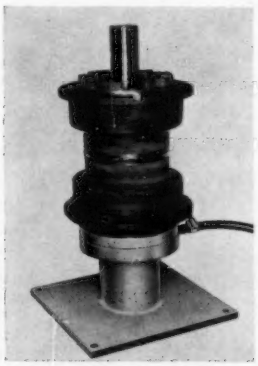
Rainy Sprinkler Sales, the irrigation division of L. R. Nelson Mfg. Co., Inc., 609 W. Lake, Peoria, Ill., has announced a self-



propelled, self-steering machine that automatically moves irrigation laterals up to 60 ft. Operated by one man, the new machine handles any lengths of 3, 4, 5, or 6-in. tubing with couplers, risers and sprinkler heads intact. Each joint of pipe reportedly is moved in about 30 seconds, above tall crops and automatically placed at the desired new location. The unit mounts on a standard high-clearance tractor and is operated by remote control at the end of the boom.

New Greasing Fixture

Owatonna Tool Co., 359 Cedar St., Owatonna, Minn., has developed a new special greasing fixture for grease-loading Allis-



Chalmers crawler tractor truck wheels and track idler assemblies which have solid shafts. The new greasing fixture, OTC No. AC-400, consists of a basic stand and six special adapters to handle truck wheels and track idlers on HD-6, HD-11, HD-16, and HD-21 crawler tractors.

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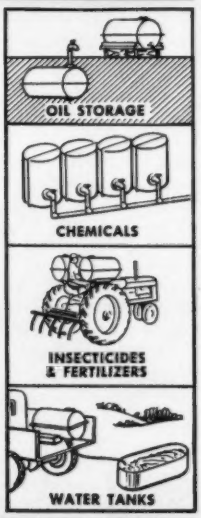

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NEW FILM RELEASES

Concrete in the '60's: Report No. 1. 16mm, 23½ min., color, and sound. For information write to: Portland Cement Association, 33 W. Grand Ave., Chicago 10, Ill.

This film, a continuation of the newsreel series issued annually since 1957, highlights outstanding construction projects, news events and new applications of concrete during the past year.

Fundamentals of Manual Shielded Arc-Welding Techniques. 16 mm, 45 min. (2 reels), color, and sound. May be obtained by contacting your local representative of Air Reduction Sales Co., a division of Air Reduction Co., Inc., listed in the telephone directory.

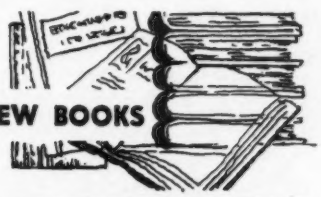
This film has been adapted from General Electric Company's previously released six-film series, "Inside Arc-Welding". Part 1 covers flat and horizontal arc-welding techniques and is 22 min. in duration. The 23-min. second reel studies vertical and overhead arc-welding procedures.

The New Look in Modern Farming. Available from Stran-Steel Corp., Detroit 29, Michigan.

This film gently sells the farmer on using steel products for his farm building construction. It projects the feeling of a farmer talking to a farmer about a common problem, not a steel company attempting to sell the farmer something he doesn't need.

Drain Your Way to Profits. 15 min., color and sound. Write to Structural Clay Products Institute, Region 6, 120½ Welch Ave., Ames, Iowa, for information.

This film shows the benefits derived from proper agricultural drainage and contains an excellent demonstration of the water table in the soil at three different conditions: Dry, drained and saturated.



During the past few months there has been a large increase in the number of new books received for review. In order that all of these may be included in this column it has become necessary to list them only by title, author, publisher, size, and price.

Centrifugal Pumps: Selection, Operation, and Maintenance, by Igor J. Karassik and the late Roy Carter. Cloth. 7 x 10 in. 488 pages. Published by F. W. Dodge Corp., 119 W. 40th St., New York 18, N. Y. Price, $15.75.

Automatic Data Processing Systems — Principles and Procedure, by R. H. Gregory and R. L. Van Horn. 700 pages. Illustrated. Published by Wadsworth Publishing Co., 431 Clay St., San Francisco 11, Calif. Price, $11.65.

Ideas, Inertia and Achievement. 100,000 words. Published by The American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y. Price, $5.00.

Toward a New Science, by J. T. Tykociner. Published by Engineering Publications Office, University of Illinois, 114 Civil Engineering Hall, Urbana, Ill. Price, $2.00.

Recommended Practices for Metallizing Shafts or Similar Objects (Revised). 32 pages. Illustrated. American Welding Society, Dept. T, 33 W. 39th St., New York 18, N. Y. Price, $1.00.

Key to Smoley's, by G. F. Wolters. Paper. 4½ x 7 in. 80 pages. Illustrated. George F. Wolters, P.O. Box 475, Ormond Beach, Fla. Price, $1.50.

Science Survey 1, 1960, edited by A. W. Haslett and John St. John. Published by The Macmillan Co., 60 Fifth Ave., New York 11, N. Y. Price, $5.75.

Digest and Summary of Organophosphorus Patents, Parts I and II. Paper. 8½ x 11 in. Part I, 98 pages. Part II, 136 pages. Published by Science Information Associates, P.O. Box 2284, Houston 1, Texas. Price, $9.00 each or $16.00 for the set of two.

Specifications for Pesticides, Second Edition. Cloth. 6¼ x 9½ in. 523 pages. Illustrated. Published by World Health Organization, Palais des Nations, Geneva, Switzerland. Price, $10.00.

Dictionary of Mechanical Engineering, by Alfred Del Vecchio. Cloth, 6¼ x 9½ in. 346 pages. Illustrated. Published by Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y. Price, $6.00.

Creative Engineering Design, by Harold R. Buhl. 6¾ x 9½ in. Cloth. 195 pages. Illustrated and indexed. Published by Iowa State University Press, Press Building, Ames, Iowa. Price, $3.95.

Saline Water Conversion, Advances in Chemistry Series 27. Paper. 6 x 9½ in. vi+ 246 pages. Illustrated. Order from Special Issues Sales, American Chemical Society, 1155 16th St., N.W., Washington 6, D. C. Price, $5.85.

Insect Life and Insect Natural History, by S. W. Frost. Paper. 5½ x 8½ in. viii+ 526 pages. Illustrated and indexed. Published by Dover Publications, Inc., 180 Varick St., New York 14, N. Y. Price, $2.25.

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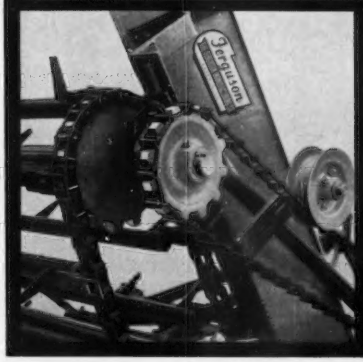

Locke's new Steel Pintle Chain is used for the conveyor of this Ferguson two-row peanut digger. Locke attachment links connect the conveyor bars to the conveyor chain. A Locke Steel Detachable Sprocket Chain drives the conveyor and shaker from a power take-off. Cast sprockets are used throughout. Both types of Locke Steel Chain — Pintle and Detachable Sprocket — are designed and carefully fabricated for uniformity of pitch, exceptional wear resistance, and rugged dependability — all at low cost. Write for catalog.

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MANUFACTURERS' LITERATURE

Literature listed below may be obtained by writing the manufacturer.

Commercial Use of Delrin

E. I. du Pont de Nemours & Co., Wilmington, Del. — A literature kit describes and illustrates Delrin acetal resin, a thermoplastic developed primarily for use in areas previously dominated by metals.

Farm Structures Planning Guide

Stran Steel Corp., Detroit 29, Mich. — An 8-page "Farm Structures Planning Guide" contains a check list covering basic factors to be considered in planning an efficient farm layout. These factors include: Site, location, drainage, grading, sanitation, efficient work routines and building types and sizes. It also provides recommendations on building systems for: Beef cattle, dairy cows, swine, poultry and eggs, grain storage and drying.

Fiberglass Building Panels

Filon Plastics Corp., Dept. F-3, 333 N. Van Ness Ave., Hawthorne, Calif. — An illustrated brochure entitled "Free Daylight for Farm Buildings" cites how plastic panels may be used for skylights, sidelights, and glazing in barns, animal shelters, storage sheds, hog houses, portable canopies, poultry houses, fences, and machinery sheds. It also lists types, sizes and configurations of the panels.

Milking Handbook

The DeLaval Separator Co., Poughkeepsie, N. Y. — A 40-page illustrated handbook of milking details the elements of all factors related to milking, including theory and practices. Topics include procedures of hand and machine milking methods; how to maintain sanitary conditions for milking; the anatomical process of the cow during milking; and the development of the milking machine.

Feed Mill Machinery and Equipment

Grain Processing Machinery Manufacturers Association, 400 W. Dartmouth Rd., Kansas City 13, Mo. — The first edition of the Feed Mill Machinery and Equipment Purchasing Guide is a 16-page reference aid in locating and selecting equipment needed for the storage, processing, and delivery of grains and feeds.

Moisture Meter Chart

Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J. — To assist in the use of the Bouyoucos moisture meter, a chart is affixed to its back. The model BN-2A meter is a compact, transistorized, battery-operated unit used in conjunction with gypsum soil blocks. The chart shows at what depth to buy the soil blocks for each type of crop and at what percent moisture to irrigate the various texture soils. Color tags, attached to the wire leads of the soil blocks, show the depth at which each block has been buried. The color scheme is related to the chart information.

Self-Priming Centrifugal Pumps

Chain Belt Co., Construction Machinery Section, Milwaukee 1, Wis. — A 4-page bulletin, No. 61AGC-P describes and illustrates complete line of self-priming centrifugal pumps. Data and information is included on general purpose, diesel, electric motor, high head, closed diaphragm, and non-powered pumps, ranging in capacities from 5,000 to 90,000 gph.

Flexible Couplings

Acme Chain Corp., 821 Main St., Holyoke, Mass. — A 4-page, 2-color bulletin, No. 10 describes and illustrates flexible couplings, with fixed bores and plain bores for reboring, as well as covers. Standard sizes and prices are also listed.

Radiation Dosimeter Reader

G. K. Turner Associates, 2524 Pulgas Ave., Palo Alto, Calif. — A 2-page leaflet, Bulletin RDR describes the accessory equipment by which any standard Turner fluorometer is converted into a means of reading dosage of ionizing radiation. Applications are listed, as well as equipment recommendations and instrument specifications. A list of references also is included.

Air Compressors

Lincoln Engineering Co., 4010 Goodfellow Blvd., St. Louis 20, Mo. — A 16-page, 2-color catalog (No. 20) covers complete line of air compressors for automotive, industrial and contractor applications. Data is included on both gasoline and electric driven models, as well as illustrations and descriptions of compressors available with either horizontal or vertical tanks. Also shown is a cross-sectional view of the basic Lincoln compressor and loadless starting device.

Flexible Cushion Couplings

Dodge Manufacturing Corp., Mishawaka, Ind. — Bulletin 901B, a 24-page piece, describes and illustrates expanded line of Para-flex flexible cushion couplings. Product photographs, engineering drawings, and actual installation pictures are included with descriptions of standard, high speed, and flywheel types of couplings. Other data includes horsepower ratings, dimensions, prices, and weights.

Electrical Contacts

Tricon Manufacturing Co., 8010 S. Wallace, Chicago, Ill. — An 8-page, 2-color bulletin entitled "A Basic Guide to Electrical Contacts" includes charts covering applications and technical data for the various contact alloys and specifications of the most commonly employed stock contacts. Other sections of the guide discuss points to be considered in the design, specification and purchase of rivet contacts, laminated contacts, spring and blade components and complete assemblies.

Controlled Speed Systems

U. S. Electrical Motors, Inc., P.O. Box 2058 Terminal Annex, Los Angeles 54, Calif. — A new 8-page brochure entitled "Controlled Speed Systems" is a revision of a previously issued brochure under the same title. The new brochure incorporates the advances made in central control instrumentation and panel design, and in signal transmission methods within process-controlled automatic systems. Twelve typical systems, illustrated with 3-dimensional schematic drawings, are included as follows: Liquid level control; pressure control; centerwind drive; speed sensitive control; load control; position or link synchronization control; temperature control; dancer roll control; range drive control; multiple-drive conveyor control; grinder control; and lathe control constant cutting speed.

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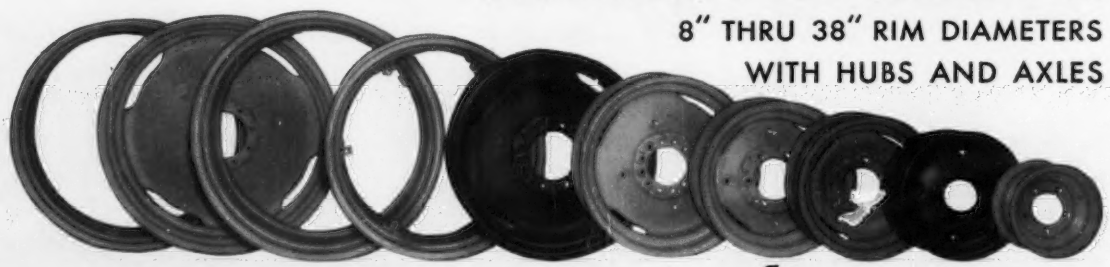

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Steel Buildings

Ceco Steel Products Corp., Dept. 7, 5601 W. 26th St., Chicago 50, Ill. — A 4-page brochure (No. 7112) describes and illustrates the Ceco Commander, a steel, clear-span, pre-engineered building. Illustrations show how it can be varied for different types of applications calling for structures 32 ft to 100 ft wide, and 12 ft to 20 ft high, such as stores, showrooms, offices, manufacturing plants, shops, garages, schools, and related structures. Also discussed is Rib-Drain roofing and the principle which makes it weathertight.

Sprockets

Browning Manufacturing Co., Maysville, Ky. — Catalog CD-10-4-A, a 4-page piece, illustrates and describes sprockets with shear pin hubs and split taper bushings. It also contains complete specifications and engineering data.

Flexible Metal Hose

Universal Metal Hose Co., 2133 S. Kedzie Ave., Chicago 23, Ill. — A 10-page bulletin, No. IPB-Sec. 3A(a) covers a selection of flexible metal hose specially designed for gravity or pneumatic transfer of grains and bulk materials where resistance to severe abrasion and corrosion are required. Specifications and prices are also included.

Conversion Factor Wall Chart

Precision Equipment Co., 4411E Ravenswood Ave., Chicago 40, Ill. — A conversion wall chart is a reference table for engineers and other executives. Included are common conversions such as inches to centimeters or watts to hp, as well as many conversions that are difficult to locate in reference manuals (for example atmospheres to Kgs/sq cm, cm/sec to miles/hr, cu ft to liters, microns to meters, quintal to lbs, etc.).

Torque Converter

The Eimco Corp., P.O. Box 300, Salt Lake City 10, Utah — Bulletin L-1078, a 24-page book entitled "Why a Torque Converter is Standard Equipment in the Eimco Tractor Unique Power Trains," outlines through pictures, graphs, cartoons, and sketches just what torque is and how a torque converter works.

Variable Speed Sheaves

T. B. Wood's Sons Co., Chambersburg, Pa. — A 16-page, 2-color bulletin, No. 25103 describes and illustrates two types of motion-control variable-speed sheaves — "MS" sheaves rated at from 2 to 15 hp and "MCS" sheaves rated at from 7.5 to 20 hp. Companion pulleys and sheaves, variable-speed belts, and motion control motor bases are also covered.

Farm Equipment Literature

Allis-Chalmers Manufacturing Co., Farm Equipment Division, Box 512, Milwaukee 1, Wis. — The four following literature pieces are offered:

A 16-page booklet (No. TL-2376) describes and illustrates unit type, hi-speed hill, and drill and wheel track planters for row crops;

A 4-page bulletin (No. TL-2404) describes and illustrates the 4-row corn head for model C gleaner combine;

An 8-page bulletin (No. TL-2405) describes and illustrates models 170 and 150 2-row mounted corn pickers, the former designed for use with model 47 tractor, and the latter for the D-15 and D-14 tractors;

A 4-page bulletin (No. TL-2403) describes and illustrates the model 2-S cotton stripper for the D-17, WD-45, and WD tractors.

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PERSONNEL SERVICE BULLETIN

Note: In this bulletin the following listings current and previously reported are not repeated in detail. For further information, see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this bulletin, request form for Personnel Service listing.

Positions Open — March — O-67-107, 76-108, 77-109, 71-112. **April**—O-95-117, 163-119. **May**—O-198-121, 199-122, 212-123, 218-124, 226-125. **June**—O-257-126, 257-127, 265-128, 259-129. **July** — O-284-130. 286-131, 293-132, 294-133, 294-134. **August**—O-310-136, 329-137, 334-138, 337-139, 341-140.

Positions Wanted — March — W-58-11, 56-12, 75-14. **April**—W-112-17, 135-18, 142-19, 115-20, 160-21, 161-22, 164-24, 166-26, 171-27, 178-28. **May**—W-187-29, 190-30, 97-31, 200-32, 201-33, 202-34, 203-35, 204-36. **June**—W-244-37, 236-38, 264-39. **July**—W-228-41, 213-42, 285-44, 280-45, 290-46, 219-47, 287-49, 296-50. **August** — W-181-51, 306-52, 307-53, 303-54, 305-55, 304-56, 323-57, 317-58, 318-59, 330-60, 333-61, 302-62.

NEW POSITIONS OPEN

Agricultural Engineer for project engineering work on dairy farm equipment with established, aggressive manufacturer. Midwest. BSAE, BSME, or equivalent experience. Dairy farm background and 2 years or more in farm equipment design. Must be creative and have the desire and ability to achieve engineering success on product assignments. Excellent opportunity for creative engineer. Location in pleasant Wisconsin resort community. Salary open. O-350-141

Agricultural Engineer (Professional Engineer III rating) for preparation of reports on water resources of selected river basin areas for state water resource agency. Midwest. BSAE or BSCE. Experience in hydrology and hydraulics essential. Design experience on reservoirs and water supply systems desirable but not essential. Registration as professional engineer required. Persons not meeting this requirement might qualify as engineering technician or engineer-in-training at slightly lower salary. Expanding organization presents good opportunities for advancement. Salary $7,200 with annual increases of $360 up to $8,640. O-311-142

Agricultural Engineer for project responsibilities on design and development of feed handling equipment with a well-established midwest manufacturer. Experience 5-8 years. Age 30-45. BSAE or ME or equivalent in practical experience. Salary open. O-371-143

NEW POSITIONS WANTED

Agricultural Engineer for design and development work in power and machinery with manufacturer or consultant. Any location in U.S.A. Limited travel. Married. Age 30. No disability. BSAE, 1951, Virginia Polytechnic Institute. Design and development experience 10 years, including one year on tillage and cultivating tools; 9 yr. on harvesting equipment. Available on 60 days notice. Salary open. W-352-63

Agricultural Engineer for power and machinery design and development with manufacturer or machine maintenance for processor. Midwest or West. Married. Age 36. No disability. BSAE, 1950, Pennsylvania State University. Registered Professional Engineer. Farm background. Progressive engineering experience to senior project engineer. Military service 2 yr. in U.S. Air Force. Available Sept. 15. Salary open. W-358-64

Agricultural Engineer for design, development, research, or teaching, in power and machinery with manufacturer, college, or federal agency. Any location. Will travel. Married. Age 26. No disability. BS, 1959, Michigan State University. MS expected December 1961, South Dakota State College. Experience as graduate assistant. Available January 1962. Salary open. W-351-65

Agricultural Engineer for design, development, or research on power and machinery or farm structures with manufacturer or federal agency. Midwest or East preferred. Married. Age 23. No disability. BSAE expected December 1961. Experience part time in college, on research in grain drying; part time in school and 2 summers full time as engineering aide with USDA, on fruit harvesting. Military service in Army, nearly 2 yr. Available January 1962. Salary open. W-370-66

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Ammons, Justus M. — Dist. agr. eng., Carolina Power and Light Co., Dunn, N. C.

Berg, Robert F. — Building engr., plant eng. dept., International Business Machines Corp. (Mail) R.R. 1, Mazeppa, Minn.

Brock, Sanford W. — Mgr., product education and sales training, J. I. Case Co. (Mail) 1428 Florence Ave., Racine, Wis.

Brodnicki, James S. — Agr. aid, Cornell University. (Mail) Tweitmann's Trailer Park, 346 Ithaca-Dryden Rd., Freeville, N. Y.

Coss, Buford — Vice-pres. and gen. mgr., Independent Mfg. Co., Inc., Box 208, Neodesha, Kans.

Davis, Leonidas W. — Gen. mgr., farm equip. div., and vice-pres., Allis-Chalmers Mfg. Co. (Mail) 8128 W. Wisconsin Ave., Wauwatosa 13, Wis.

Doggett, Raymond C. — Implement sales mgr., Allis-Chalmers Mfg. Co. (Mail) 7116 W. Edgerton Ave., Milwaukee 20, Wis.

Doolittle, Ronald H. — Agr. sales engr., Hayes Steel Products Ltd., St. Catharines, Ont., Canada

Felton, Kenneth E. — Asst. res. prof. and res. and ext. agr. engr., agr. eng. dept., University of Maryland, College Park, Md.

Jaquith, Burton K. — Pres., Technical Industries, Inc., 2711 S.W. Second Ave., Fort Lauderdale, Fla.

Johnson, A. Kenneth — Proj. engr., Delavan Manufacturing Co. (Mail) 115 S. Market St., Madrid, Iowa

Kabega, Dennis G. — Exec. engr., Water Development Dept., Uganda, Africa. (Mail) c/o A. E. Duke, FAS, U.S. Department of Agriculture, Washington 25, D. C.

Lim Fat, Maxime E. L. — Agr. engr., eng. div., Department of Agriculture, Richelieu, Mauritius

McMichael, W. Leigh — Sales mgr., Borroughs Tool and Equipment Corp., 2429 N. Burdick St., Kalamazoo, Mich.

McNair, Leon M. — Field rep., National 4-H Service Committee, Inc., 59 E. Van Buren St., Chicago 5, Ill.

Merz, Kenneth A. — Dir. of eng., air moving divisions, Torrington Manufacturing Co., 100 Franklin Dr., Torrington, Conn.

Notman, Robert J. — Product designer, eng. dept., Massey-Ferguson Inc. (Mail) 1362 N. Hughes Ave., Fresno 5, Calif.

Oakie, Armand — Product engr., Hayes Steel Products Ltd. (Mail) 339 Grantham Ave., St. Catharines, Ont., Canada

Preston, Randall L. — Serv. rep., John Deere Co. (Mail) 5370 Fifth St., N.E., Minneapolis 21, Minn.

Reddi, Gotam R. — Agr. engr., Government of Andhra Pradesh, Hyderabad (DN), India. (Mail) PIO/P. 386-12-10100, ICA, Washington 25, D.C.

Reimer, Borge R. — Chief product engr., Hayes Steel Products Ltd., St. Catharines, Ont., Canada

Roycraft, Franklin T. — Mgr., sales eng., The Martin Sales Co., P.O. Box 550, Mansfield, Ohio

Ruiz, Raphael M. — Agr. engr., Instituto Agronomico de Campinas, Caixa Postal 28, Campinas, S. Paulo, Brazil

Schell, James D. — Proj. engr., Industrial Truck Div., Clark Equipment Co. (Mail) 107 N. 28th St., Battle Creek, Mich.

Shelton, Robert L. — Sr. proj. engr., Hesston Manufacturing Co., Hesston, Kans.

Simpson, Forrest L. — Des. engr., International Harvester Co. (Mail) 5301 Virgil, Memphis 8, Tenn.

Stegner, Art W. — Storage products mgr., farm equipment div., Butler Manufacturing Co. (Mail) 7513 Grandview Lane, Overland Park, Kans.

Teresbessy, Lou L. — Asst. chief engr., Finco, Inc., Aurora, Ill.

Thayer, Arlie J. — Des. engr. II, Farm Equipment Res. and Eng. Center, International Harvester Co. (Mail) 8529 Parkview Ave., Brookfield, Ill.

Voss, Fountain G., Jr. — (With U.S. Army) R.R. 2, Laurinburg, N. C.

TRANSFER OF MEMBERSHIP

Arya, Surendra V. — Asst. prof., agr. eng. dept., Indian Institute of Technology, Kharagpur, (S.E.R.), India (Associate Member to Member)

Mast, Aquila D. — Dir. of res. and dev., Daffin Corp. (Mail) 1316 Clayton Rd., Lancaster, Pa. (Associate Member to Member)

Patel, Shantibhai, M. — Agr. engr., Jyoti Ltd., Baroda 3 (Western Railway) India (Associate Member to Member)

Roth, Lawrence O. — Asst. prof., agr. eng. dept., Oklahoma State University, Stillwater, Okla. (Associate Member to Member)

Thomas, Jeffrey J. — Field test engr., Massey-Ferguson (U.K.) Ltd. (Mail) 25 The Chesils, Coventry, England (Associate Member to Member)

Turnquist, Paul K. — Instr., agr. eng. dept., Oklahoma State University, Stillwater, Okla. (Associate Member to Member)

Womble, George E. — Product engr. and head, tillage div., J. I. Case Co. (Mail) 2620 Lindale Rd., Rockford, Ill. (Associate Member to Member)

STUDENT MEMBER TRANSFERS

Bridgham, Daniel O. — (University of Maine) R.R. 2, Mechanic Falls, Me.

Crawford, William B. — Agr. eng. dept., Pennsylvania State University, University Park, Pa.

Duncan, George A. — Agr. eng. dept., University of Kentucky, Lexington, Ky.

Hedstrom, Warren E. — (University of Maine) R.R. 1, Stockholm, Me.

Hunnewell, Charles G. — (University of Maine) R.R. 1, North Anson, Me.

Shaw, Robert R. — (University of Maine) Caribou Rd., Ft. Fairfield, Me.

Sprague, William R. — (University of Kentucky) R.R. 3, Sturgis, Ky.

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Index to Advertisers

Acme Chain Corp. 504
Aetna Ball & Roller Bearing Co. 520
Armco Drainage & Metal Products, Inc. 475
Auto Specialties Manufacturing Co. 519
Bearings Company of America Div., Federal-Mogul-Bower Bearings, Inc. 461
Chain Belt Co. 473
Dayton Industrial Products Div., Dayco Corp. 466, 467
Deere & Co. 465
Automotive Gear Div., Eaton Mfg. Co. 517
Electric Wheel Co. 514
Federal-Mogul Div., Federal-Mogul-Bower Bearings, Inc. 471
Fenwal, Inc. 515
Goodyear Tire & Rubber Co. 457
H. D. Hume Co. 505
Kohler Co. 503
Link-Belt Co. ..... 3rd Cover
Locke Steel Chain Co. 513
Lundell Mfg. Co. 460
Molded Fiber Glass Co. 512
National Rain Bird Sales & Engineering Corp. 518
National Seal Div., Federal-Mogul-Bower Bearings, Inc. ..... 2nd Cover
New Departure Div., General Motors Corp. 459
Nice Ball Bearing Co. 468
The Ohio Rubber Co. 511
Perfect Circle Corp. 476
Raybestos-Manhattan Inc. 469
Rockford Clutch Div., Borg-Warner Corp. 464
Stow Mfg. Co. 509
Texaco, Inc. 474
Timken Roller Bearing Co. ..... 4th Cover
West Coast Lumbermen's Association 462-463
Wisconsin Motor Corp. 507

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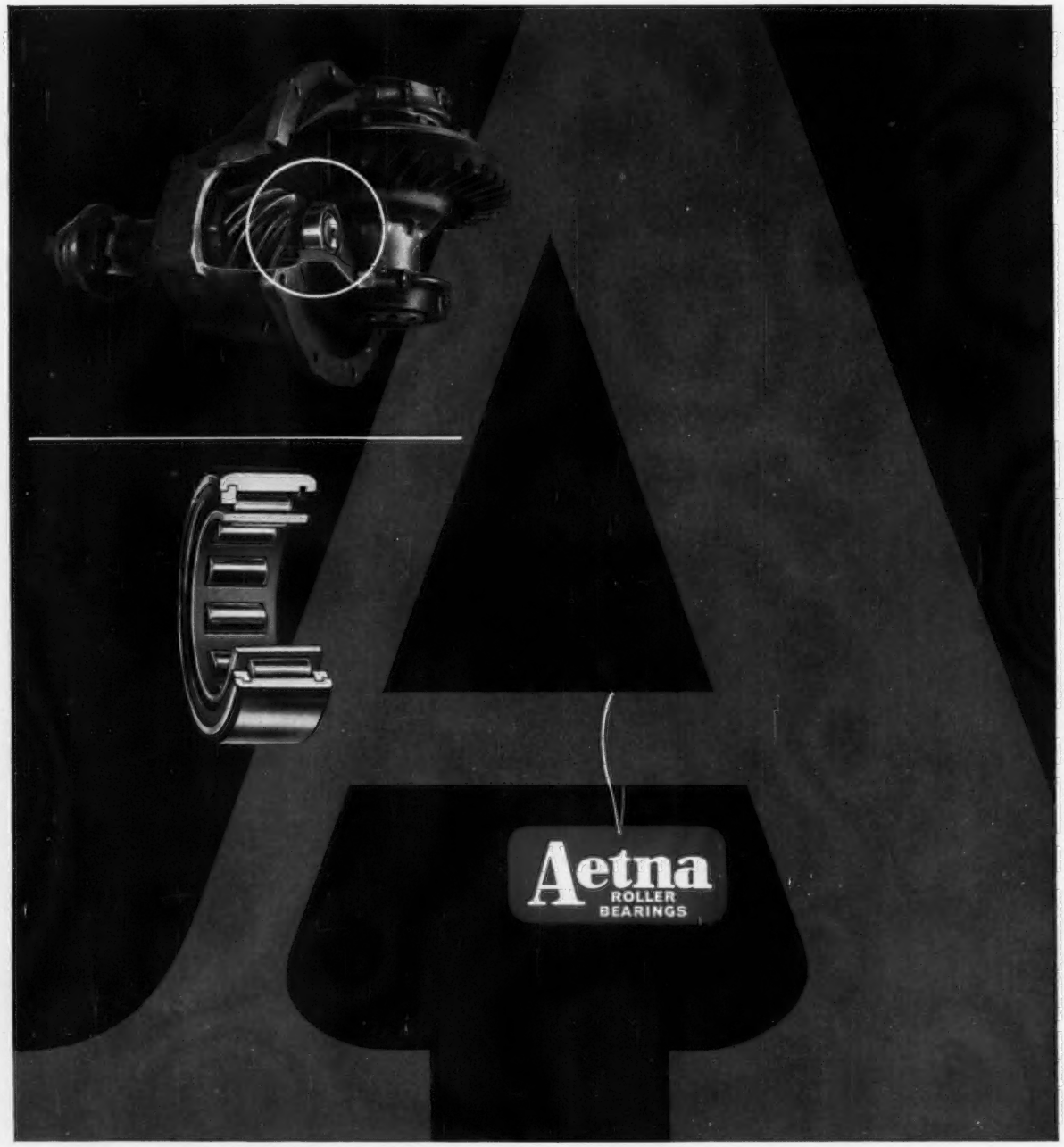

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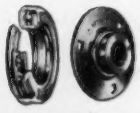

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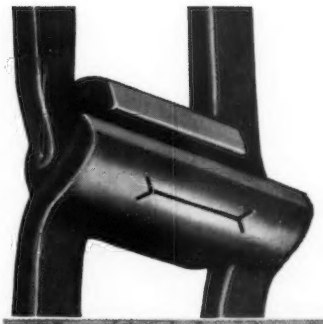

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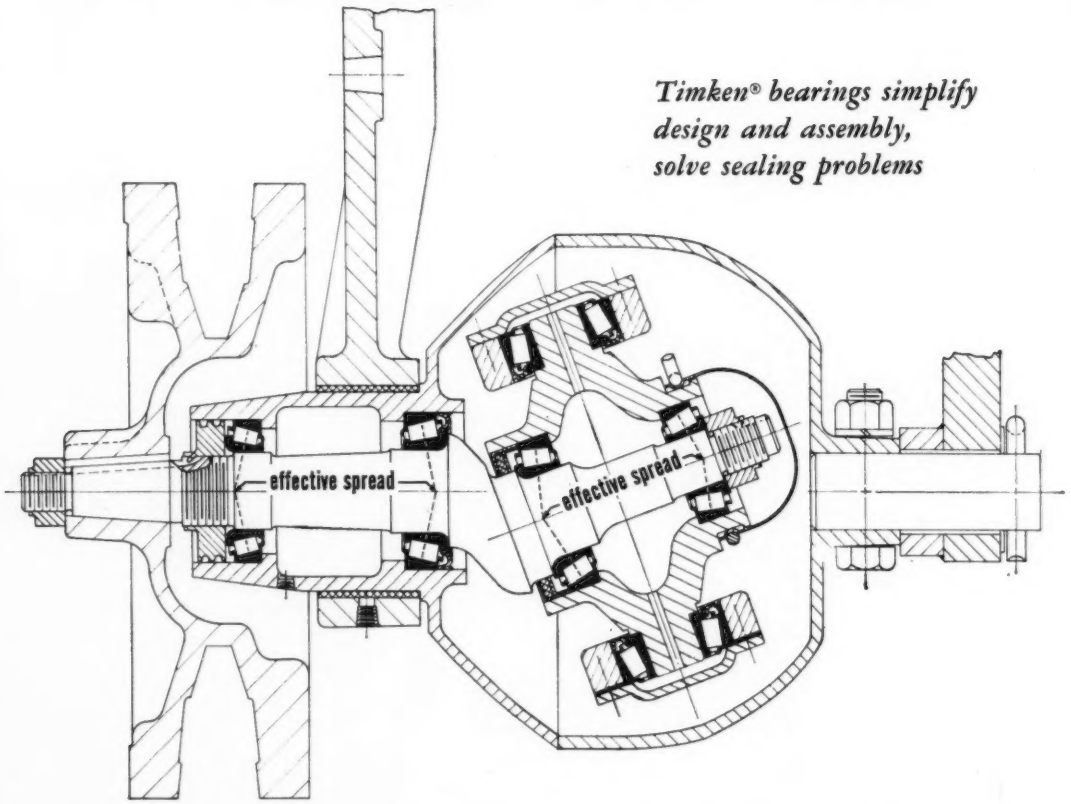

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Timken bearing applications are on the wobble shaft, flywheel shaft and oscillating yoke. Also, in the No. 100 trailing model, the transport wheels are equipped with Timken bearings for fast highway transport. IH engineers specified the new design Timken "green light" bearings, made by high-speed mechanization, to simplify design and get high load capacity in a small space. And by permitting indirect mounting of the wrist-action and flywheel shafts, where maximum stability is required, they let engineers take advantage of the effective spread principle of Timken bearings (see above).

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